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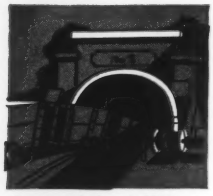
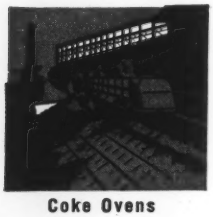
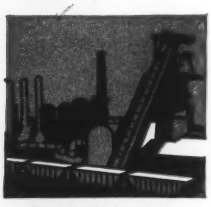


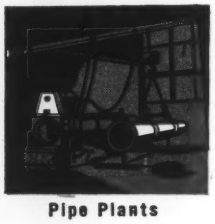
Ore and Coal Mines



Coke Ovens



Blast Furnaces



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CIVIL ENGINEERING

JANUARY 1955
VOL. 25 • NO. 1

THE MAGAZINE OF ENGINEERED CONSTRUCTION

• ARTICLES

Walter S. Merrill	33	**Greece gets nation-wide power system**
George L. Wilson *Harvey J. Roberts*	38	**West Virginia Turnpike workmen protected against health hazards in tunnel construction**
Clement J. Freund	41	**Employers, ethics, and young engineers**
D. E. Oelschlager	42	**Prestressed concrete foundation takes 8,000-ton press**
E. O. Martinson	46	**Power cranes and shovels—selection by charts and graphs II. Operating costs**
C. N. Conner	50	**Flexible pavements developed for modern traffic**
W. G. Huber	52	**Alcan transmission line built to resist ice and wind loads**
John B. Wilbur	57	**Is engineering being taught backward?**
Harry A. Williams	57	**More training for young civil engineers**
	58	**Precast slabs form air-intake plenum**
Robert L. Ketter *Bruno Thürlimann*	59	**Can design be based on ultimate strength?**

• SOCIETY NEWS

	64	**San Diego Convention, February 6–11**
	65	**New York offers advantages for Engineering Center**
	66	**Engineers and scientists plan nuclear congress**
	67	**Column research to yield safer, cheaper structures**
	68	**Ernest E. Howard Award established by ASCE**
	69	**Notes from the Local Sections**
Joseph H. Ehlers	76	**From the Nation's Capital**

• NEWS BRIEFS

78	**Construction seen as setting new record in 1955**
78	**High-level bridge to span Buffalo Ship Canal**
80	**Dynamic road testing method demonstrated**
83	**November construction activity sets record for month**
83	**Contract awarded for Army Package Reactor**

• DEPARTMENTS

22	News of Engineers	97	Positions Announced
28	New in Education	98	Non-ASCE Meetings
31	Do You Know That	100	New Publications
58	Engineers' Notebook	105	Men and Jobs Available
61	The Readers Write	107	Applications for Admission
74	Scheduled ASCE Meetings	108	Equipment, Mtrls, Methods
84	N. G. Neare's Column	114	Literature Available
86	Recent Books	117	From the Manufacturers
90	Deceased	120	Index to Advertisers
119	**Proceedings Papers Available as Separates**		

Two more new Statler Hotels — the Dallas Statler and the Hartford Statler — have frames of reinforced concrete. The major factors which influenced Hotels Statler Company in their selection of reinforced concrete were lower costs and flexibility of design. The ingenious design of the 18-story Dallas Statler—using a two-column bay and flat-slab cantilever floors in conjunction with reinforced concrete—threw the cost estimate on guest-room wings entirely out of the usual "hotel" class into a far less expensive class.

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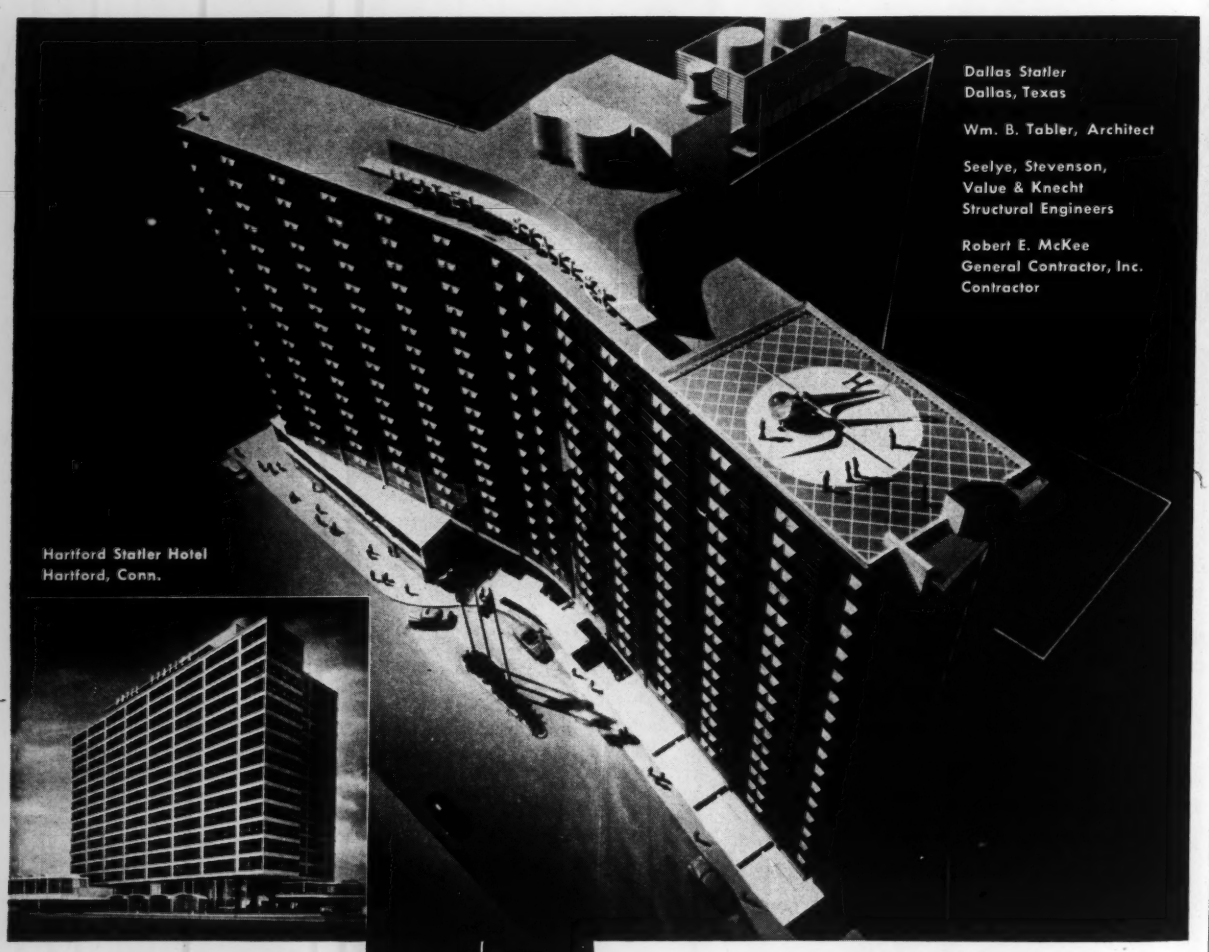

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Dallas, Texas

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Robert E. McKee
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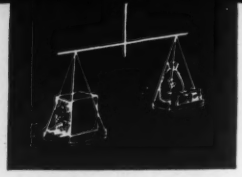

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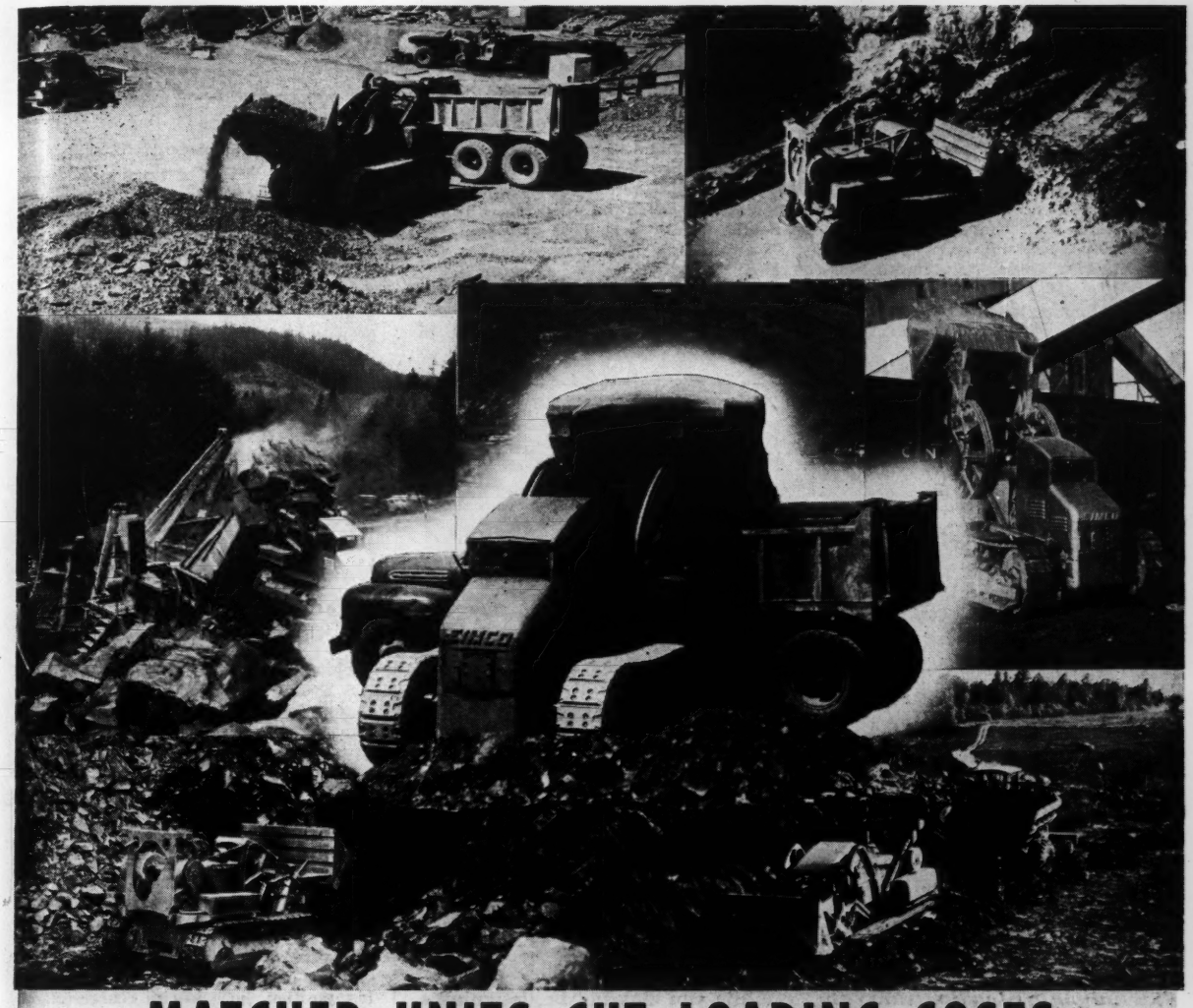

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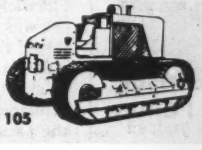
Eimco 105



Eimco 105 with bulldozer attachment

NEWS OF ENGINEERS

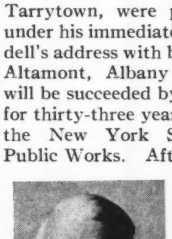
Warren E. Wilson, president of the South Dakota School of Mines from 1948 to 1953, became George Westinghouse professor of engineering education at Pennsylvania State University on August 1. The professorship was established jointly by the university and the Westinghouse Education Foundation for the purpose of studying engineering education and guiding the students enrolled in a new curriculum designated the curriculum in engineering science. Through an error that is much regretted Dr. Wilson was incorrectly reported to have returned to the South Dakota School of Mines in the "News of Engineers" department of the December issue.

Clifford A. Betts, of Bethesda, Md., for many years active in the District of Columbia Section of ASCE, received the Washington Society of Engineers Award at the 49th annual banquet of the society on November 17. Mr. Betts was cited "for accomplishments in engineering that have made an outstanding contribution to the advancement of engineering knowledge and practice, and to the maintenance of a high professional standard." At the present time he is associated with the Chicago firm of Alvord, Burdick and Howson as a consulting engineer. Prior to forming this connection last September he was on the engineering staff of the U.S. Forest Service in Washington.

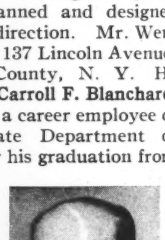
Morrison G. Cain, Jr., Lieutenant Commander, CEC, US Naval Reserve, who has been officer in charge of construction at the Glenn L. Martin Co., Baltimore, Md., has been released from active duty and will resume his association with the John W. Cowper Company, engineers and constructors of Buffalo, N.Y.

Eldon V. Hunt has joined the Alberta Gas Trunk Line Company, Ltd. as chief engineer at its headquarters in Calgary, Canada. Until recently he was connected with Ebasco Services, Inc. of New York as construction superintendent. Before joining Ebasco Mr. Hunt was formerly general manager of the Key City Gas Co., Dubuque, Iowa, and was district superintendent of the Transcontinental Gas Pipeline Corp.

Edward W. Wendell, deputy chief engineer, New York Thruway Authority, retired as of December 1 after 46 years of service with the State of New York. In his position he was in charge of all bridges. On the New York State Thruway System all the bridges with the exception of the Hudson River crossing at Nyack-Tarrytown, were planned and designed under his immediate direction. Mr. Wendell's address with be 137 Lincoln Avenue, Altamont, Albany County, N. Y. He will be succeeded by **Carroll F. Blanchard,** for thirty-three years a career employee of the New York State Department of Public Works. After his graduation from

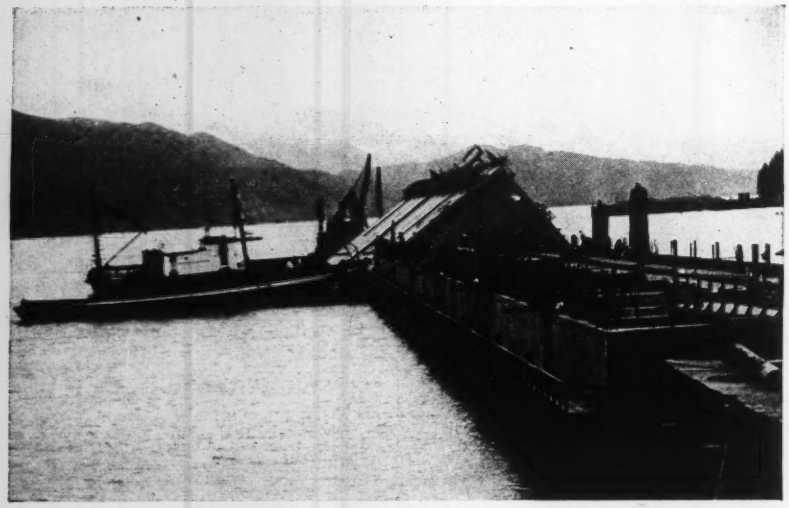


C. F. Blanchard



E. W. Wendell

Norwich University in Vermont in 1912, he was engaged in railroad work. He joined the Watertown office of the Department in 1921, later transferring to Albany as assistant engineer. In 1945 he became principal engineer, a title he has held to the present time.



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Floating Plastiment-concrete structures are not new. . . . Of the seven American projects featured as Famous Floating Concrete Structures in the May issue of the Journal of the American Concrete Institute, five were constructed of Plastiment-concrete . . . most of the foreign jobs shown also contained Plastiment, supplied from the fourteen overseas Sika manufacturing organizations.

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Nathan Henry Gellert, president of the Seattle Gas Co., Seattle, Wash., will resign on March 15. He plans to re-enter the consulting field and will continue to act as consultant to the firm. A graduate of Yale and the Sheffield Scientific School there, Mr. Gellert has long been in the utility business both as engineer and as president of numerous companies. Prior to going to Seattle in 1941, he was engaged as a public utility consultant.

N. H. Gellert

Thomas Lane, Colonel, Corps of Engineers, who has been engineer of the Army Field Forces at Fort Monroe, Va., became engineer commissioner of the District of Columbia on December 10. Prior to his assignment at Fort Monroe, Colonel Lane was on the personal staff of General Sturgis, Chief of Engineers, as an assistant for policy planning. He is a graduate of West Point and the Massachusetts Institute of Technology and holds the Distinguished Service Medal.

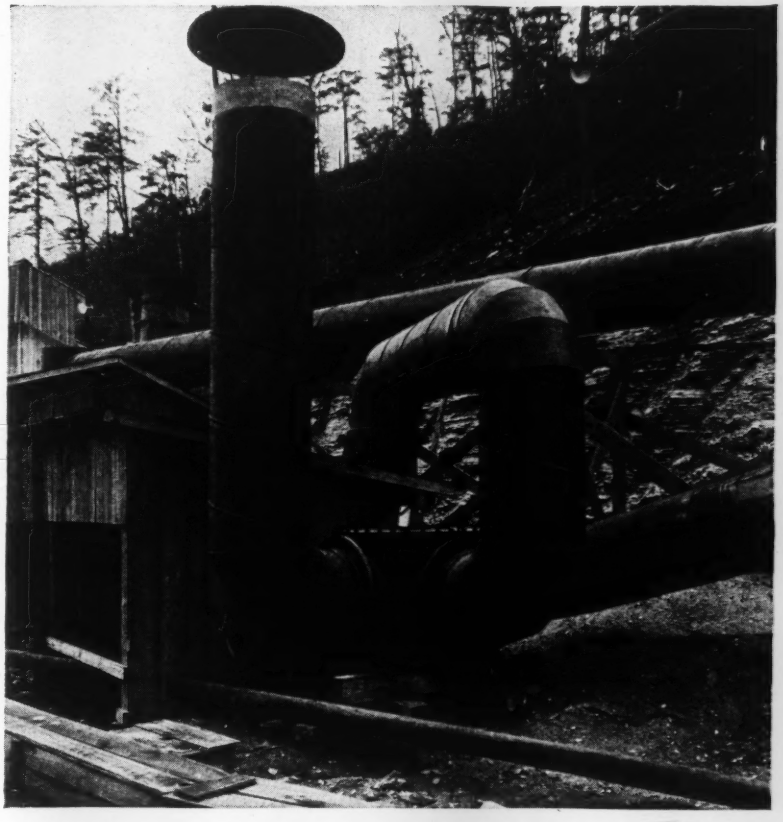
Henry Alfred Stalfort has recently been made vice-president of the Consolidated Engineering Company, Inc., of Baltimore, Md. Mr. Stalfort has served the company in various capacities since his graduation from Cornell University in 1934. Most recently he was project manager.

Walter J. Kackley will return to federal service in Washington, D.C. after an absence of three years in private construction management in that city. He will be consulting engineer for the Public Buildings Service, General Service Administration. Mr. Kackley has had long experience in the design and construction of public buildings. He will work on special studies and investigations, and prosecution of claims.

Joseph G. Hunter, who retired on December 15 as director of the California Public Utilities Commission, San Francisco, is opening a private consulting practice which will advise transportation agencies. Mr. Hunter joined the Public Utilities Commission in 1920 as assistant engineer in the hydraulic's division. Since then he has held a number of important positions in the field—one of them as chairman of the subcommittee of the Advisory Committee on Motor Vehicle Legislation. His home is in Burlingame.

(*Continued on page 24*)

MAN-MADE WEATHER for UNDERGROUND SERVICE



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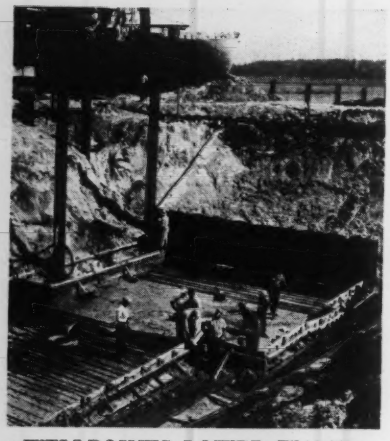

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News of Engineers

(*Continued from page 23*)

David F. Giboney was appointed chief engineer of the Ingersoll Steel Division, Borg-Warner Corp., New Castle, Ind., on November 9. Previously Mr. Giboney was assistant chief engineer.

G. William Bailey, Jr., head of the estimating department of Raymond Concrete Pile Co., New York City, has been appointed chief engineer. He will take the position of **Warren N. Riker** who was appointed in July as district manager of the Boston area (October 1954 issue, page 27).

G. W. Bailey, Jr.

Norbert W. Weinberg and **L. Harrison Newport,** who have been with the firm of Koebig and Koebig, consulting engineers of Los Angeles, Calif., since 1953, have recently been promoted to hydraulic engineers. Formerly Mr. Weinberg was civil engineer with the California Division of Water Resources and Mr. Newport was civil engineering assistant with the Los Angeles Department of Water and Power.

Eugene Adams Yates, chairman of the board of the Southern Co. and Southern Services, Inc., announces the removal of their New York offices from 20 Pine Street to 250 Park Avenue.

John A. Logan, since 1946 a staff member of the Rockefeller Foundation in the Division of Medicine and Public Health at the London School of Hygiene & Tropical Medicine, has joined the faculty of Northwestern University as professor and chairman of the department of civil engineering. Before the war he held teaching positions at Iowa State College and the University of Missouri and later was an engineer in private industry. Professor Logan's major research interest is in development of environmental control methods and techniques.

Joe Reginald Fuller has been awarded a Frances E. Markoe scholarship for the study of business administration at Harvard University. Mr. Fuller is a graduate of Texas A. and M. College, class of 1951.

Lewis Adams Stanley, until recently engineer for the Oregon Klamath River Commission at Klamath Falls, has been appointed state engineer. He will succeed **Charles E. Stricklin** who died recently (obituary in the February 1955 issue). A registered engineer, Mr. Stanley has had fifteen years experience in the state engineer for the as assistant engineer and engineer's office hydroelectric commission. In 1946 he was engaged in irrigation and highway work in Afghanistan for the Morrison-Knudsen Company.

Jamil Malaika and **Yervant Ouzounian,** of Baghdad, Iraq, announce the formation of a partnership, Ouzounian and Malaika, for general consulting engineering work at Z1/1 Orfaliyyah, Baghdad. Both Dr. Malaika and Mr. Ouzounian have been engaged in professional practice in Iraq.

Alfred E. Johnson, since 1947 chief engineer of the Arkansas State Highway Department, Little Rock, will become executive secretary of the American Association of State Highway Officials on January 1. He suceeds **Hal H. Hale,** who has resigned to accept a position with the Association of American Railroads (December issue, page 22). Mr. Johnson's headquarters will be in Washington, D.C.

Francis G. Yates, formerly office engineer for the City of Santa Rosa, Calif., is now structural engineer of the City of Las Vegas, Nev.

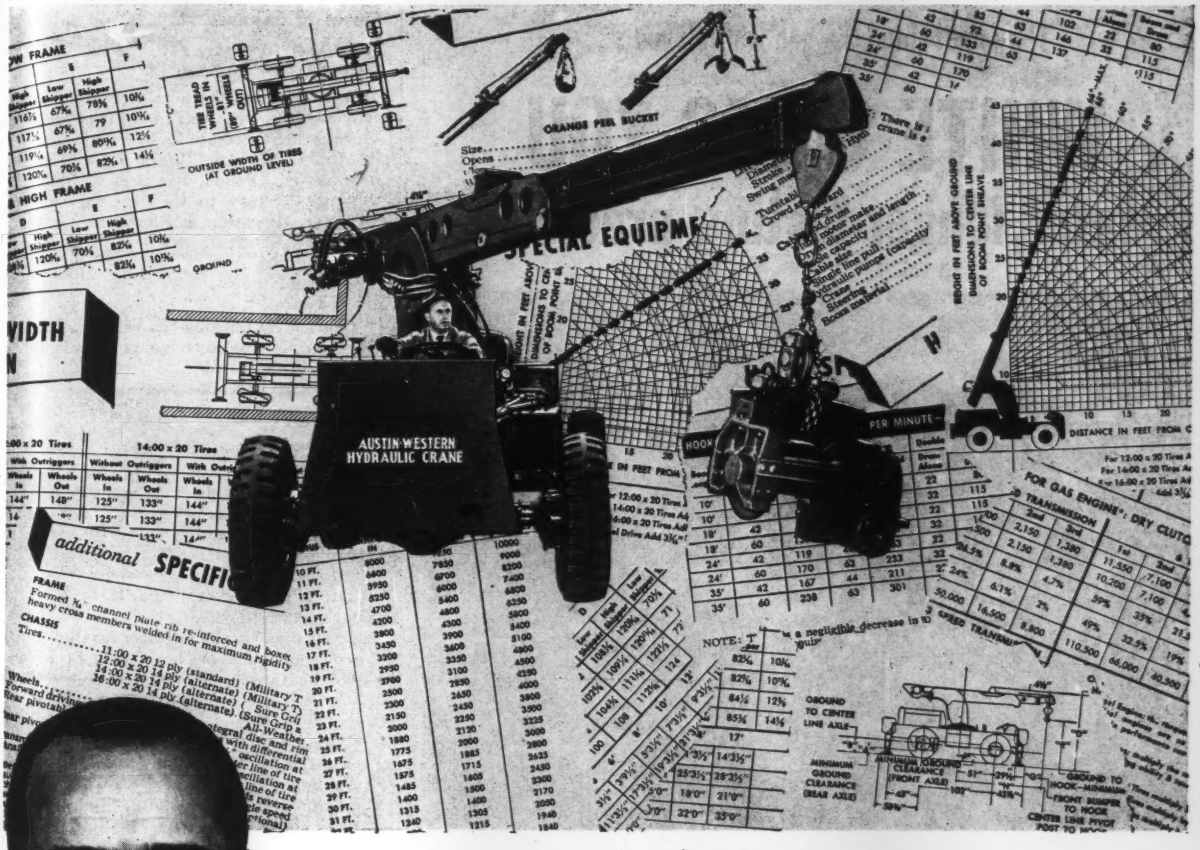
Michael A. Powills, Jr., formerly traffic engineer with the Chicago Plan Commission and the Bureau of Street Traffic of the City of Chicago, has become affiliated with Associated Consultants of Evanston, Ill., specialists in street traffic and transportation.

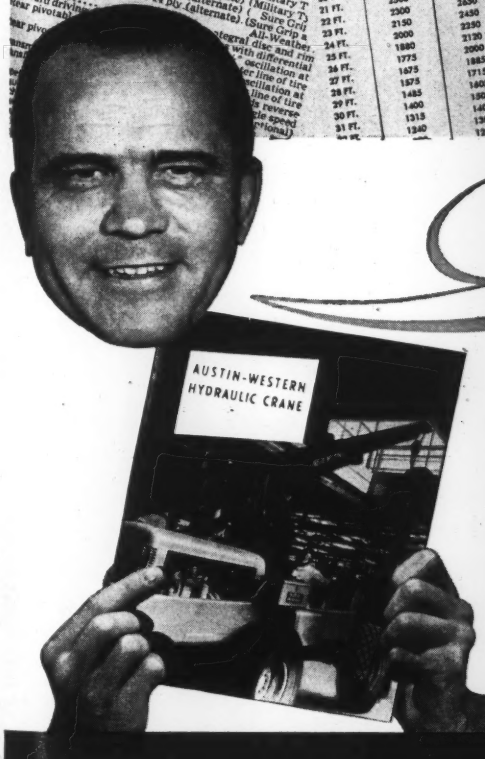
Paul C. Brown and **Robert R. Conner,** colonels, Army Corps of Engineers, USAF Installations Office, are the new officers in charge of USAF construction. Colonel Brown was formerly with the South Atlantic Division in Atlanta, Ga., and Colonel Conner with the South West Division in Dallas, Tex. They were chosen to head world-wide construction activities for the Air Force and will have offices in Washington.

Wells Nash Thompson, since 1946 vice-president of the H. K. Ferguson Co. and manager of the company's New York office, is now president. In his twenty-five years with the company, Mr. Thompson has supervised design and construction of industrial facilities both here and abroad. For eight years he was Far Eastern Branch Manager in Japan. In 1942, he was made chief engineer of the company and in 1944 was promoted to vice-president in charge of engineering.

Neil Welden has been appointed bridge engineer of the Iowa State Highway Commission. A resident of Ames, Iowa, Mr. Welden has been a member of the Commission staff since 1933 and, until his appointment, was bridge designer.

(*Continued on page 26*)





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News of Engineers

(*Continued from page 24*)

J. P. Naegamvala, until recently executive engineer on the Lower Tapi Valley Development Project for the government of India's Central Water and Power Commission, Poona, has been appointed deputy secretary to the Government of Bombay, Irrigation & Electricity, Public Works Department.

Charles H. Buckius has retired as chief engineer of the Pennsylvania Department of Highways to join the investment banking firm of Lehman Brothers of New York City as highway consultant. He started work for the Highway Department in 1907 and, except for brief interruptions, has been with it ever since. From 1920 to 1928 he served as district engineer for the Highway Department in New Castle, Scranton and Allentown.

C. H. Buckius

Paul H. Hardaker, until recently structural engineer for the Bushnell Steel Co., Jacksonville, Fla., is establishing a structural engineering practice in that city on January 1. The firm's name will be Paul H. Hardaker and I. M. Huddleston.

Elbert Saunders Tillotson, general manager of Steers-Grove in charge of the construction of the Port-Lyautey Base in French Morocco, was recently honored by the Sultan of Morocco who conferred on him the title of Officer of the Ouissam Alaouite. The medal and diploma of the rank were presented to Mr. Tillotson by the chief of the French Liaison Mission at a reception in Port-Lyautey given in his honor. Of his thirty-seven years as a construction engineer, Mr. Tillotson has spent fourteen years abroad on construction problems for the defense program. He plans to leave Morocco shortly.

Tulla Ethan Bliss, division engineer of the St. Louis-San Francisco Railway Co., Fort Worth, Tex., will retire on May 1. Mr. Bliss has been with this company for forty-five years.

Henry M. Chance has been elected president of United Engineers & Constructors, Inc., of Philadelphia, Pa. Mr. Chance has been with the company for the past eighteen years. In 1946 he became assistant to the president and in 1949 was elected vice-president and a director.

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New in Education

New Daniel and Florence Guggenheim Jet Propulsion Fellowships are available. They will be awarded for graduate study at Princeton University and the California Institute of Technology, at the Jet Propulsion Centers established in 1948 by the Daniel and Florence Guggenheim Foundation. Fellowships carry a stipend ranging from $1,200 to $2,000 annually, plus tuition, for study toward advanced degrees. They are open to qualified college graduates with suitable engineering or scientific undergraduate preparation, outstanding technical ability, and deep interest in rockets and jet propulsion. Applications must be received by March 1, 1955, and will be acted upon by April 1. Candidates will be notified promptly. Applications and descriptive booklets may be obtained from your dean, or direct from the Daniel and Florence Guggenheim Foundation, 120 Broadway, New York 5, N.Y.

Carnegie Institute of Technology offers opportunities for graduate study and research in the College of Engineering and Science. There are teaching assistantships, fellowships and research assistantships open for the academic year, 1955–1956. Teaching assistantships for able graduate students, paying $1,680 for the first year and $1,780 for the second, are open in most of the college departments. Part-time research jobs, with pay comparable to a teaching assistantship, are available in several departments and laboratories. Outstanding students may apply for graduate fellowships which are offered to permit advanced study and research and carry liberal grants plus tuition. Applications should be submitted not later than March 1, and forms may be obtained from the Dean of Graduate Studies, Carnegie Institute of Technology, Pittsburgh 13, Pa.

Two Highway Engineering Fellowships are available at the University of California. The Automotive Safety Foundation has established two $2,000 fellowships for graduate study in highway transportation engineering at the University's Institute of Transportation and Traffic Engineering. The fellowships, providing for one year of study, are open to graduates with experience in highway engineering. Applications for the Fall of 1955 must be submitted before February 15, and forms may be obtained from the Dean of the Graduate Division, University of California, Berkeley 4, Calif.

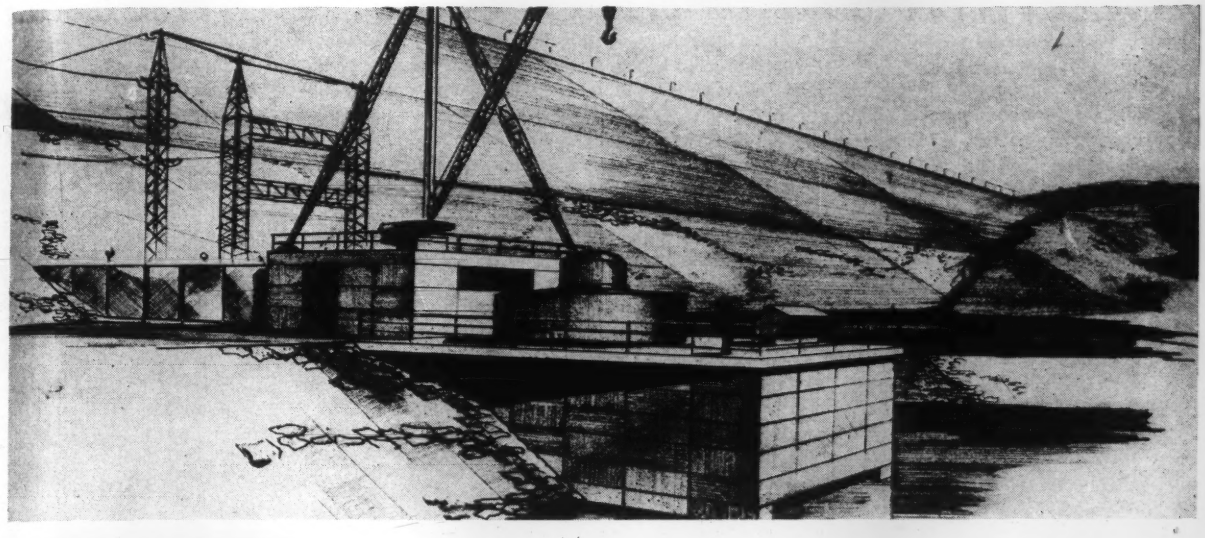
The University of North Carolina has entered into a three-year contract with the Institute of Inter-American Affairs of the United States Foreign Operations Administration to strengthen the sanitary engineering educational and research programs in the National School of Engineering of Peru. The contract, calling for an expenditure of some $185,000, will be administered by the University's School of Public Health through its Department of Sanitary Engineering. The purpose of the project is to integrate laboratory teaching with the undergraduate program and to initiate and develop research. Two ASCE members on the staff of the Sanitary Engineering Department at the University of North Carolina, Professor Marvin L. Granstrom and Daniel A. Okun will go to Peru this year. In the exchange program Peruvian faculty and engineers will come to the United States for special training.

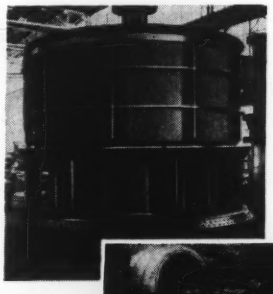
Illinois Institute of Technology has a new building, its 19th new structure in the past 12 years. Ground-breaking ceremonies were held on December 2 for the latest campus addition, a $775,000 glass-and-steel structure of advanced design. It will house the Institute's recently created Division of Architecture, Design and City Planning.

Northwestern University offers evening and Saturday courses for graduates in civil engineering. To provide civil engineers in the Chicago area an opportunity for advanced training in special fields, a series of graduate evening courses will be initiated in the Technological Institute during the Winter Quarter. The courses, open both to special students and those working for advanced degrees, are Sanitary Chemistry, Flow in Open Channels, Structural Design and Ground Water Flow and Seepage. Information may be obtained from J. A. Logan, Chairman, Civil Engineering Department, the Technological Institute, Northwestern University, Evanston, Ill.

TVA Chatuge Dam Power Plant Installs LEFFEL Hydraulic Turbine

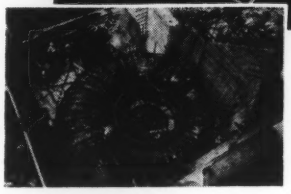
a progress report at the beginning of 1955





Completely assembled turbine except for riveted scroll case.

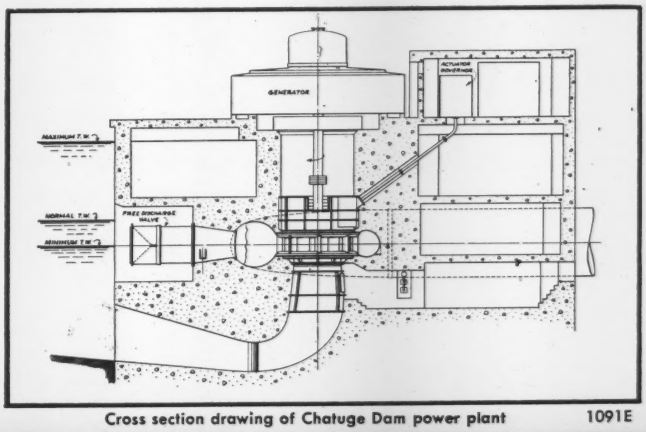
Powerhouse evacuation and draft tube floor with forms in place.



Assembled scroll case in position from above.

In the new power plant at Chatuge Dam, a Tennessee Valley Authority earth-fill dam near Murphy, North Carolina, another efficient hydraulic turbine installation by Leffel is being completed. The turbine is rated at 13,800 H.P. under a head of 110 feet at 180 R.P.M. A photographic progress report of the installation is shown here.

All over the world Leffel hydraulic turbines harness water power economically and efficiently. Why not let us help you with your project, whether it be expansion, rehabilitation or a new installation? Please write, wire or phone for further information.



Cross section drawing of Chatuge Dam power plant 1091E

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18′ *of water lowered to rock*

by WELLPOINTS

on Ledyard Dam in Groton, Connecticu

Boulders piled on left came out of this core trench excavation!

Fred Onuparik, contractor of New London, Conn., made headline progress on this difficult job. His problem was to excavate to bedrock 20′ of material consisting of coarse sand, gravel, and boulders—plus 18′ of water.

It took only one week to install a Moretrench Wellpoint System in this rough ground.

Pumping started at twelve noon.

At 4 P.M. on the same day, the contractor had two 2½ yard shovels digging "in the dry".

EXCAVATION WAS COMPLETED SIX WEEKS AHEAD OF SCHEDULE!

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do you know that

Safer, cheaper structures are in the cards? Research in column behavior, sponsored by Engineering Foundation's Column Research Council, is expected to lead to improved design practice. Results of the project to date are reported on page 67.

Management tends to underrate employee objectives? In a recent spot check of management and labor in twenty-four industrial plants, reported in the December issue of *Nation's Business*, employees rate "appreciation of work done" first in a listing of ten morale factors. Supervisors put it eighth. Employees place "feeling in on things" in second place and "good wages" in fifth. Supervisors put "feeling in on things" in tenth place and "good wages" at the head of the list.

A new device may provide accurate sixty-day weather forecasts for the entire hemisphere? A Naval Ordnance Research Computer (NORC), just completed for the Navy by International Business Machines, is said to be capable of making a sixty-day weather forecast for a whole hemisphere in a one-day mathematical computation.

The cement industry is a billion-dollar business? Cement ranks fourth in value in mineral production in the United States, following the traditional basic minerals—petroleum, coal, and iron ore. In 1955 some 157 plants in thirty-six states and Puerto Rico will produce 50,000,000 tons of cement, which will play a basic role in the building boom.

Of our 37,840 members, 22,244 are registered in the various Technical Divisions? If you are one of the 15,596 members who are not receiving the free technical papers automatically distributed to those registered in one of the Divisions, use the coupon in the advertising section to register.

Health hazards in tunnel construction can be overcome? Successful efforts to protect workmen engaged in tunnel driving on the West Virginia Turnpike are described by industrial hygienists for the West Virginia Department of Health in an article reprinted through the courtesy of the A.M.A. (page 38).

San Francisco is to have an earthquake-proof skyscraper? The 25-story Equitable Life Assurance Society Building, now nearing completion in San Francisco, will be the "strongest skyscraper ever built," according to *Architectural Forum*, because it is the city's first tall building conforming with the earthquake safety regulations incorporated in the San Francisco Building Code in 1948.

New York, too, has its adherents for the Engineering Center? The advantages New York offers as a site for the proposed Engineering Societies Center are reported by a task force of the Committee for a New Engineering Societies Building in New York (page 65).

Construction is seen as setting a new record in 1955? New construction activity this year is expected to reach an all-time high of $39\frac{1}{2}$ billion, 7 percent above the record-breaking $37 billion volume indicated for 1954. This is the consensus of outlook estimates prepared jointly by the Departments of Commerce and Labor (page 78).

There is a new boon for winter drivers? As a contribution to reducing skidding accidents, engineers for the Carborundum Co. at Niagara Falls, N.Y., have developed a special aluminum oxide abrasive called Highway Safety Grain, to be spread on highways. Tests show that the stopping distance of cars going 30 mph was reduced by more than 30 percent when the oxide was applied.

Engineering enrollment is up in the colleges? In contrast with the past five years of declining college enrollments, says Dr. Raymond Walters, president of the University of Cincinnati, in his thirty-fifth annual school survey, enrollment in 1954 was up 7.6 percent. The greatest increases are in education and engineering.

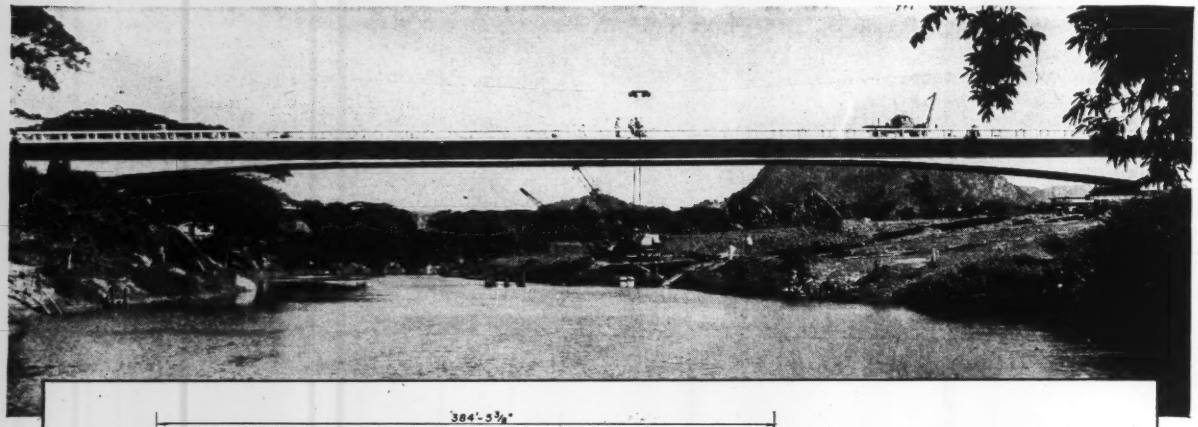
The Society is to have a new prize? Details of a new award established in memory of Past-President Ernest E. Howard to recognize outstanding contributions in the structural field are given on page 68.

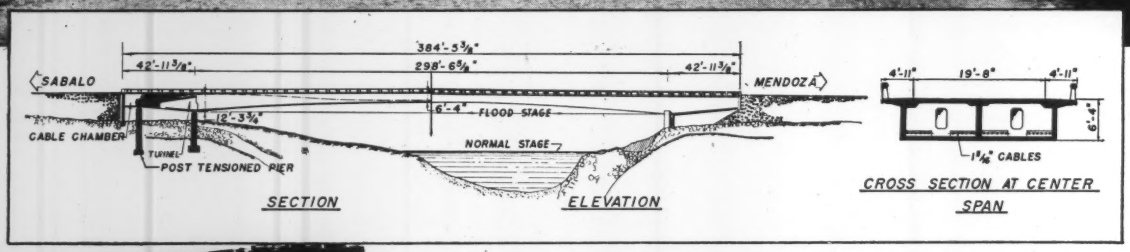
A contract form is available for use on engineering construction projects? The fifteen-page printed form, prepared by AGC and ASCE with the help of AIA, is available at Society Headquarters for 25 cents each, or $20 per 100 copies.

Louisiana is to have the longest bridge in the world? The Louisiana parishes of Jefferson and St. Tammany have sold a $46,000,000 bond issue, paving the way for construction of the longest bridge in the world—a 24-mile span across Lake Pontchartrain to be known as the Greater New Orleans Expressway (September 1954 issue, page 87).

Man, What a Span!

Cuba's Cuyaguateje River Bridge Has Post-Tensioned Reinforced Concrete Box Girder with 299-Ft. Clear Span — Longest of Type in Hemisphere





● Engineers in the Republic of Cuba continue to forge ahead with the imaginative use of prestressed concrete bridge design. This span over the treacherous Cuyaguateje River, near Mendoza, is a post-tensioned structure of 299 ft. clear center span, with 43-ft. cantilevers at each end.

Believed to be the longest of its type in the Western Hemisphere, the center span is a two-cell box girder varying in height from 12 ft. 3 in. at the ends to 6 ft. 4 in. at the center. Depth-to-span ratio at center is 1 to 47. Roebling cables 1-11/16 in. and 1-9/16 in. diameter were used for post-tensioning.

Prestressed, long-span construction was dictated by a number of reasons, all sound. Substantial savings in concrete and steel meant low initial cost—competitive with other types of construction. Savings on maintenance are substantial, including elimination of painting, of added importance under tropical conditions. Absence of piers avoids possibility of damage from cresting waters which carry much debris.

Soundness of the prestressed design and its practicability from a construction standpoint are evidenced by this slim, graceful structure which bespeaks quality in every line.

RIO CUYAGUATEJE BRIDGE on Pan American Highway, near Mendoza, Cuba
Designed by
STRUCTURAL SECTION, COMISION DE FOMENTO NACIONAL;
ING. LUIS SAENZ, Chief Engineer
Contractor: **ING. FERNANDO MUNILLA**

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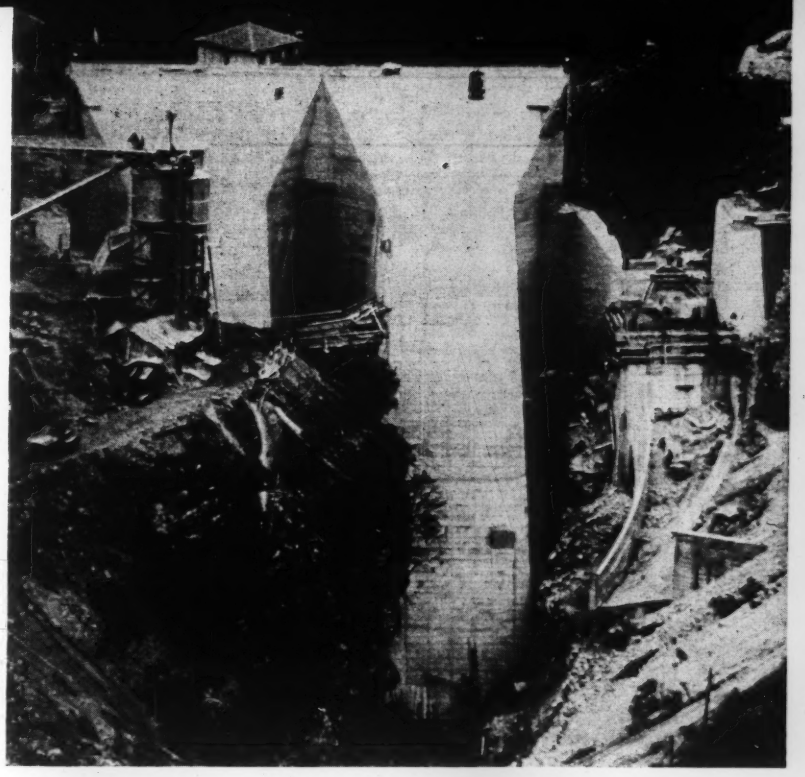
CIVIL ENGINEERING

WALTER S. MERRILL, M.ASCE

Civil Engineer, Ebasco Services Inc.

Chief Civil Engineer, Public Power Corporation, Athens, Greece



Downstream face of Pidima Dam is seen during construction. Design and supervision of construction were by an Italian firm, with construction by Greek contractors.

GREECE GETS NATION-WIDE POWER SYSTEM

The Kingdom of Greece is enjoying the unique experience of having a nation-wide electric power and light system built for it during the five-year period, August 1, 1950, to July 31, 1955 (Fig. 1). Training of Greek management and operating personnel in every branch of the utility industry is proceeding simultaneously with construction. The power plants, transmission lines, substations, and 15-kv distribution systems now being constructed and interconnected to the existing facilities will provide a nation-wide power pool. This is doubtless the first time an entire country has been provided, in one brief period, with a completely new power system.

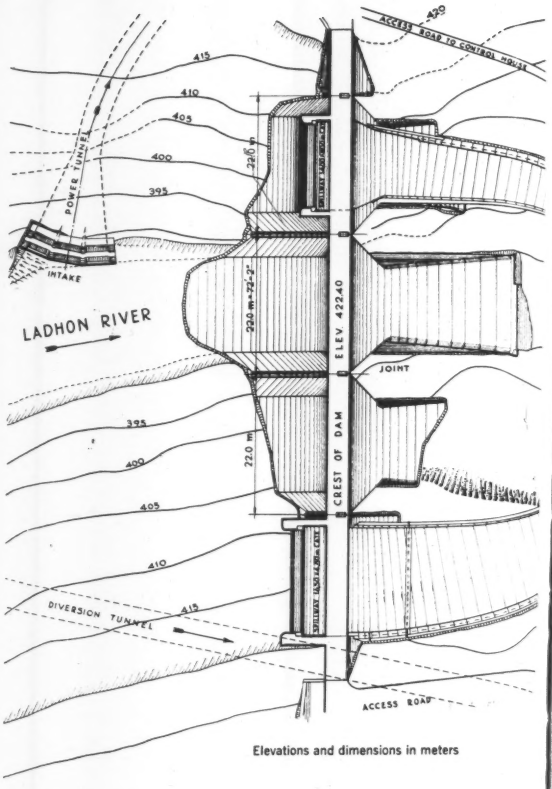
Mainland Greece has an area approximately equal to that of Florida and a population of 8,000,000 people, three times that of Florida. It is a very mountainous country with limited amounts of agricultural land and comparatively undeveloped natural resources. In 1950 the production of electricity per capita in Greece was less than 100 kwhr per year for the country as a whole, and only about 160 kwhr per year where electric service was available.

With the exception of the capital area of Athens and the Piraeus (population about 1,500,000), where the Athens-Piraeus Electricity Co., Ltd. (APECO) has operated for many years with a total installed capacity of 134,000 kw in two thermal stations, there was little electric service in Greece. The 175,000-kw capacity now being built will still leave Greece low in per capita use, but there is a large potential power demand which will continue to increase rapidly.

Situated on the Mediterranean Sea in a strategic location, Greece has been plagued by wars since time immemorial. It was occupied for $3^1/_2$ years by the Italians and Germans during World War II, and at the war's termination a Communist uprising nearly succeeded in taking over the country. As a result of these struggles, Greece was devastated and in a very bad economic condition.

Shortly after the end of World War II, the Marshall Plan was put into operation. As part of the plan to get the country back on its feet, an increased supply of electric power was considered essential. To find out what resources were available for power development, the Economic Cooperation Administration (ECA), now the Foreign Operation Administration (FOA), employed Ebasco Services Incorporated of New York, to make a study of certain rivers and of lignite fuel deposits and to develop a plan for providing the major towns and cities of Greece with electric service. This investigation, extending over most of 1949, was carried out under great difficulties, including the necessity of Army protection against bandits for

FIG. 1. Nation-wide power and light system, built for Greece at cost of $100,000,000, was started in 1950 and is scheduled for completion in 1955.



Elevations and dimensions in meters

survey parties and other personnel required in the exploratory work.

The report, made to ECA and the Greek Government early in 1950, gave specific recommendations for a power program with generating plants and transmission lines as shown in Fig. 1. The report included a study of the economy of the country, forecasts of future load, the results of an investigation of hydro sites on four rivers, the proving out of a lignite supply for a steam plant, and recommendations for a feasible plan of financing the work, which would have a total estimated cost of $210,000,000. In line with good economics for initiating a program of this magnitude, the Kremasta Project and the transmission lines shown dashed in Fig. 1 were omitted from the first stage. The final cost of the first stage will be about $100,000,000.

The several hydro projects investigated were found to be suitable if interconnected with a base-load steam plant. They would provide large amounts of secondary energy as a fuel saver. Two good hydro sites were available, one on the Vodas River in the northern part of the country (Macedonia) and the other in the southern Peloponnesus area on the Ladhon River. An especially favorable site, Kremasta, on the Acheloos River, with an ultimate capacity of 240,000 kw, will be feasible for construction at a later date. A smaller project in western Greece, on the Louros River, will be built now as an isolated project but may be interconnected with the system in the future.

There are important lignite deposits in several places, an especially large deposit area being in Ptolemais in northern Greece. This deposit is considered feasible for development to produce power at a later stage in the program. Another important lignite deposit, of 30,000,000 tons, is in the Aliveri area, about 70 miles northeast of Athens, on the island of Euboea. This lignite fuel is of low heat value but suitable for power plant use.

The power system shown in Fig. 1 places a power plant of adequate size in every important area of the country, with substations in all major load centers. The 15-kv distribution circuits, not shown on the map, will be able to reach most of the villages and cities of any size within 15 to 30 miles of the various substations.

Design and construction begin

Following approval of the comprehensive report to ECA and the Greek Government, Ebasco entered into a five-

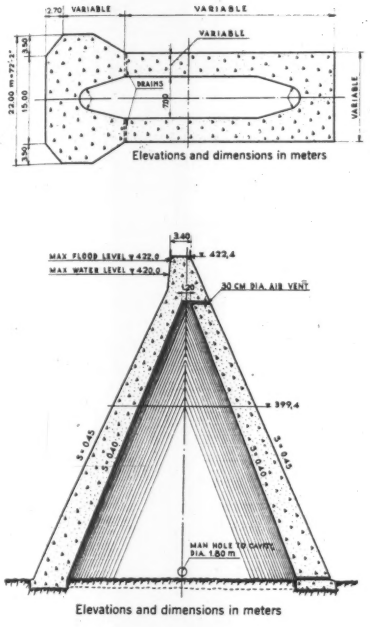


FIG. 2. Pidima Dam provides storage for Ladhon Project, in Southern Greece, which will develop 50,000 kw when completed in 1955. Plan and typical vertical and horizontal sections show design of hollow gravity-type dam, a European type estimated to cost less than an arch or solid gravity type, in spite of extra form work. Elevations and dimensions are in meters.

year management contract to supervise the design, construction, and initial operation of the power system. Engineers, construction men, accountants, and others were sent to Greece in July 1950. This force was gradually increased until sufficient personnel were available to run all parts of an operating electric utility company and to train Greeks to succeed them. At present the Greek personnel of the office and field staffs of the Public Power Corporation outnumber the American personnel about eight to one. In addition, over 50 Greeks have been or are being trained in the United States for periods of from four to twelve months. Such trainees include men from the Board of Directors of the Public Power Corp. (of Greece), and from the engineering, operating, commercial, and accounting staffs.

Financing of the Greek power program has been partly by American dollars disbursed through ECA (now FOA); partly by local currency supplied by the Greek Government as "counterpart" funds; and to a considerable extent by funds from the Greek-Italian War Reparations Agreement. The latter funds have made it possible to secure much of the equipment from Italy and have also paid for much of the engineering design and supervision of construction.

Two American firms, Burns and Roe, Inc., and The Foundation Company of New York, designed and built the 80,000-kw Aliveri Steam Electric Station, which went into partial operation in July 1953. An English firm prepared, designed, and supervised the construction of the transmission lines and substations, which were built by two Italian contractors. A French firm is similarly engaged on the 15-kv lines and distribution systems, and the construction is being done by Greek contractors.

The two larger hydro projects—Agra (40,000 kw) and Ladhon (50,000 kw)—are being designed and their construction supervised by the Italian firm, Societa Edison of Milano. The Louros Project (5,000 kw) was similarly done by a combination of the French firm, Ominum Lyonnais of Paris, and the Eter Commercial and Technical Company of Athens. The Agra Project went on the line in July 1954, and the Louros Project was dedicated in June 1954.

The general contract for the Agra and Ladhon Projects was awarded to the Italian firm late in 1950, and engineering design began immediately. Construction started in the summer of 1951. The general contract for the Louros Project was awarded early in 1951, immediately followed by design and construction. The basic pattern of project layout and plant design was given in the report submitted to, and adopted by, ECA and the Greek Government, and this has been followed with such modifications as further detailed studies showed to be desirable.

Because it differs in design from usual American practice, more detailed information is given concerning the Pidima Dam and the Ladhon Project.

Ladhon Project

The Ladhon Project, with an installation of two 25,000-kw vertical-shaft Francis units, is located on the Ladhon River in the northern Peloponnesus about 20 miles east of the ruins of the Temple of Apollo at ancient Olympia of Olympic fame. The project consists of a hollow, gravity-type dam, about 180 ft high, which provides a reservoir with 40,500 acre-ft of usable storage; a tunnel of 12.8-ft diameter approximately 5.4 miles long; a surge tank built in the rock near the lower end of the tunnel; a steel penstock varying in diameter from 10.8 to 9.3 ft; a cast-steel butterfly valve of 10.8-ft diameter, and an air inlet valve of 2.0-ft diameter at the upper end of the penstock; a concrete-frame powerhouse with two 25,000-kw units installed, each unit provided with a cast-steel roto-valve and a synchronous bypass; a substation with two 32,500-kva transformers and one outgoing 150-kv transmission line; operators' quarters at both the dam and the powerhouse; access roads and other facilities.

Reservoir. The reservoir impounded by Pidima Dam is 9.3 miles long and covers an area of 2.3 sq miles, with usable storage of 40,500 acre-ft.

Pidima Dam. The dam is of the straight gravity type made up of five hollow elements as shown in Fig. 2. This is a type of dam frequently adopted in Europe. Detailed study of an arch dam, a solid gravity dam, and the hollow gravity dam showed the latter to be the cheapest, as the increased amount of form work was more than offset by the reduced amount of concrete.

The first work was the construction of a diversion tunnel of 13.75-ft diameter through the right abutment and a low diversion weir. The diversion tunnel has a vertical shaft located a short way downstream from the dam, from which duplicate vertical gates operated by oil cylinders are controlled. These gates, following the completion of construction, will be closed and the tunnel will thereafter be used to carry a part of the flood flows. The remainder of the flood flows will be carried by two side-channel spillways. The two spillways and the diversion tunnel are designed to discharge a total of 42,500 cfs of water.

The main elements of the dam are 72 ft 2 in. long, as shown in Fig. 2. Since the downstream face of the section is roughly one-half to two-thirds as long as the upstream face, there is a considerable space between adjacent units, except at the upstream face, where the units join and are protected by a copper cutoff seal and also by a cement mortar joint placed over a tar-treated surface.

The right-bank spillway is closed by a tilting gate 64 ft long by 16.75 ft high, and the left-bank spillway is similarly closed by a gate 46 ft long by 9.84 ft high. The upper ends of the gates are connected to rocker arms which extend over piers to a long concrete counterweight.

The dam is being built on limestone rock which is somewhat broken and seamed. To insure watertightness, many holes were drilled along the upstream side of the dam and grouted under pressures up to 350 psi.

The computed maximum pressure at the downstream toe of the high central unit is 11 tons per sq ft. Some grouting was done at the downstream ends of the various units in order to consolidate the foundation rock.

Tunnel. As shown in Fig. 2, the intake to the power tunnel is just up-

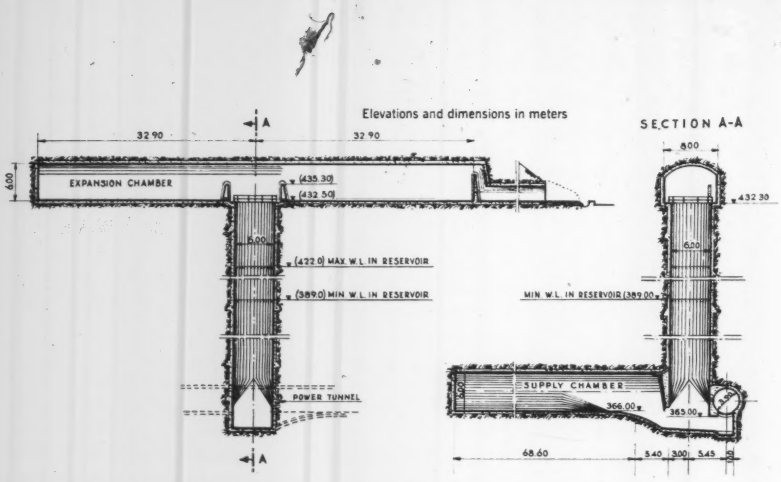


FIG. 3. Surge shaft and chambers for Ladhon Project were built underground at lower end of 5-mile tunnel. Design is for rejection of full load on two 25,000-kw units operating at 785-ft head. Elevations and dimensions are in meters.

stream of the dam. A vertical shaft for the motor-operated roller-type gate is located near the left abutment of the dam.

The tunnel was located more or less parallel to the river, resulting in an increased length of about 15 percent as compared with a straight-line tunnel between the intake and the powerhouse. This relocation, however, enabled the tunnel to be built from three principal adits, sloping slightly upward to the tunnel. These adits vary in length from 500 to 1,000 ft. One short auxiliary adit was also used near the upper end of the tunnel.

The tunnel was constructed by Italian miners and Greek laborers. A large amount of supporting material was required because of the many fractures in the rock. Initially the supporting material was timber but this proved to be costly and was changed to I-beam sections of approximately horseshoe shape.

In about one quarter the length of the tunnel, between Adits 1 and 2, concrete lining was placed by hand behind wooden forms, giving a rough surface. This surface will be plastered with cement mortar about $^5/_8$ in. thick. In the remaining sections of the tunnel, most of the concrete was placed by utilizing two Blaw-Knox type forms, built in Italy; the concrete was pumped by compressed air. Even in these sections there are places where it was necessary to place the lining by hand.

The surge tank is located 440 ft upstream from the lower end of the tunnel, and the steel penstock liner extends in to a point 115 ft below the surge tank, where the rock cover is sufficient for the maximum pressure. Because of the fissured condition of the rock, it was deemed advisable to provide reinforcing in the tunnel from the end of the penstock to a point 328 ft above the surge tank. Lining of this section of the tunnel was done by hand.

Considerable grouting was required to fill the spaces between the concrete lining and the rock. In addition to this type of grouting, which is called bond grouting, another type of grouting is being done under pressures up to 350 psi in holes drilled through the concrete and 6 ft into the rock in back of the lining. This consolidation grouting is being done to fill any cracks in the rock and to distribute pressure from the concrete lining over a larger rock area. Both the bond and the consolidation grouting are considered essential in this type of rock, unless the lining is reinforced.

The rock is largely limestone, although there are various lengths of altered rock, varying from marl to radiolarite. The cost of reinforcing the entire tunnel for maximum pressure was so high that a thorough job of grouting has been adopted. A series of water tests of the tunnel will be made by pumping water into each section between concrete and steel bulkheads near the adits. After the sections are filled, pressure will be raised to the required amount by small boiler-feed-type pumps and the leakage determined. Such hydraulic pressure tests are rather common in European tunnels when there is any question as to the stability of the rock. If cracks of any appreciable size are found or if leakage is excessive, further grouting will be done and this section of tunnel retested. If some sections of the tunnel finally require reinforcement, reinforcing steel will be placed against the concrete and covered with 3 to 4 in. of cement mortar applied by cement gun.

Surge tank. The surge tank is located near the lower end of the tunnel and is shown in Fig. 3. The shaft is 19.75 ft in diameter, lined with reinforced concrete and thoroughly grouted. Connecting to the lower end of the shaft and to the tunnel, there is a supply chamber 19.75 ft in diameter and 225 ft long, lined with concrete and thoroughly grouted. The top of the shaft is reached from the side of the mountain by an adit which connects to an expansion chamber. This chamber is 20 ft high inside the concrete lining and about 215 ft long. The expansion chamber has a semicircular arched roof and vertical side-walls.

Construction of both the expansion and supply chambers was accomplished by excavating at the roof first and building the arch; the rock below was then excavated in short sections, and the concrete walls placed.

The vertical shaft of the surge tank was excavated from the top and lined in 6-ft sections.

The surge tank is designed for full load rejection of both units with the governors operating in 2.5 sec. Under these conditions, it is estimated that the water will rise about 50 ft above normal static level.

Penstock. The steel penstock, extending from the tunnel down the face of the hill to the powerhouse, varies in diameter from 10.85 ft at the upper end to 9.3 ft near the lower end, where it branches into a wye embedded in the rock near the powerhouse. Beyond this point, penstock branches of 6.56-ft diameter extend to the roto-valves and the units. At the upper end, there is a cast-steel butterfly valve of 10.85-ft diameter and an air inlet valve of 2.0-ft diameter.

The penstock is an all-welded job, the pipe being made in Italy and sent to Greece by ship with roundabout welds joining three sections of pipe into a section about 20 ft long. These sections, in turn, were erected and the roundabout joints welded in the field. Interior finish is bitumastic enamel. The penstock has two vertical bends where massive concrete anchorages are placed. Expansion joints in the pipe are located below the anchors. The penstock is furthur supported on concrete saddles between anchors.

The synchronous bypass valves attached to the turbines are designed to pass 90 percent of the water rejected by the units at full load so that the maximum pressure rise in the penstock is limited to 10 percent. The penstock sections were water tested in the manufacturer's shop. The wye section and the penstock sections between it and the roto-valves were also water tested in place. The completed penstock will have a steel bulkhead welded to its upper end and will be tested as a unit to the maximum design pressure.

Powerhouse. The powerhouse is a concrete frame building with steel roof

trusses. This building has successfully withstood a strong earthquake shock with the only evidence of damage being a few cracks between the tile filling and the concrete frame.

The cable spreading room and battery room are located in a low building in front of the main powerhouse building with the floor level the same as the base of the generator. The control room and offices are located above the cable spreading room, and a small shop is located above the battery room. A cross section of the powerhouse is shown by Fig. 4. The powerhouse is located at the base of a rather steep hill and some distance back from the river. This required a tailrace 200 ft long, which was excavated as a tunnel rather than open cut.

The two 25,000-kw vertical-shaft Francis turbines operate under a normal static head of 785 ft at 428 rpm. The turbine manufacturer also supplied the cast-steel roto-valves, the synchronous bypasses, and the Mitchell thrust bearing. These turbines are equipped with cast-steel casings and stainless-steel runners cast in one piece.

Generation is at 15,750 v, 50 cycles, which is standard for all three of the hydroelectric plants being built. The generator and the thrust and guide bearings are cooled by circulated water supplied from a closed system.

It was originally planned to build an underground powerhouse, but this plan was abandoned when further study showed that the broken condition of the rock would result in difficulties and greater overall cost.

Switchyard. The substation has two 32,500-kva transformers stepping up the generator voltage to the 150-kv transmission-line voltage. From the transformers, the power is taken by two overhead lines to a switchyard located farther down the river, where switching facilities are provided for connection to the one outgoing line.

The Ladhon River is of considerable size and the release of water through the turbines for operation at about 35-percent load factor will provide little inconvenience to those living downstream of the plant.

This project is expected to begin commercial operation early in 1955.

H. K. Breckenridge, Chief Representative of Ebasco Services Incorporated in Greece, is General Manager of the Public Power Corporation, and Gilbert Cooley is Assistant General Manager. A staff of Americans, numbering about 65 at the maximum, has been required to manage all phases of the work in Greece. The majority of the employees on the projects are Greek; only a few technicians are from other countries.

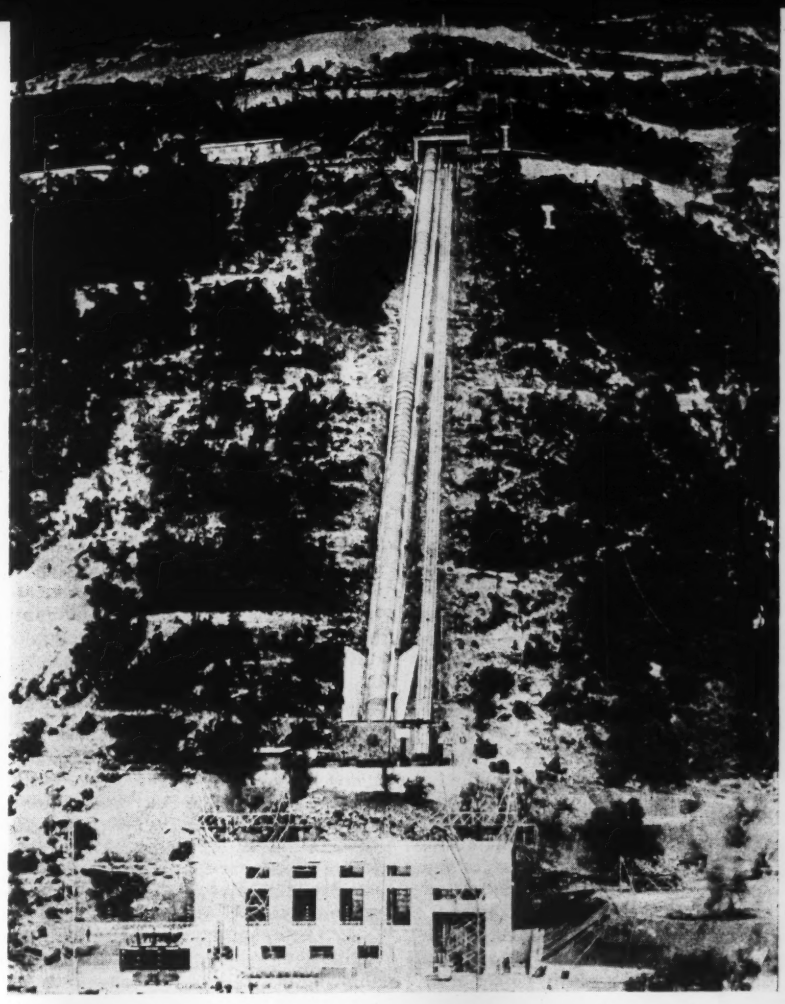
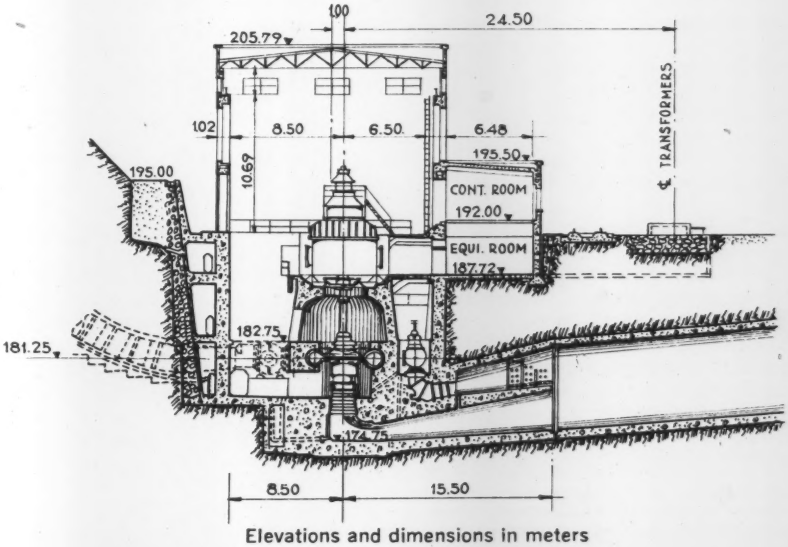


FIG. 4. Two turbines in Ladhon Powerhouse generate 50-cycle current at 15,750 v. Turbines are Francis type, vertical shaft, 25,000 kw. Transmission-line voltage is 150 kv. Single 10-ft penstock branches in wye at powerhouse to two 6.56-ft penstocks leading to turbines. Elevations and dimensions are in meters.



Elevations and dimensions in meters

West Virginia Turnpike workmen protected against

Health hazards in tunnel construction*

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Bureau of Industrial Hygiene, West Virginia Department of Health

The West Virginia Turnpike is being built as a toll road across West Virginia by the West Virginia Turnpike Commission, an organization set up by an act of the state legislature. The Turnpike Commission employed the consulting engineering firm of Howard, Needles, Tammen and Bergendoff, New York, N.Y., as the general engineering supervisor of all construction. This firm also acted as engineer on the tunnel construction. The tunnel was designed by Singstad and Baillie, Consulting Engineers, New York, and the contractor for the tunnel construction was the Bates and Rogers Construction Corp., Chicago.

The tunnel, built as part of the turnpike, is located in Kanawha County, with the south portal near the town of Standard. The excavation was made from the south portal; it is approximately 35 ft wide, 33 ft high, and 2,665 ft in length. About 100,000 cu yd of rock was removed. The finished tunnel will be in the form of a semicircular arch with straight sidewalls, providing for a roadway 24 ft wide. [See February 1954 CIVIL ENGINEERING, for a description of the turnpike and tunnel. The final section of the turnpike was dedicated early in December 1954.]

The contract between the Turnpike Commission and the contractor required observance of several provisions which had a bearing on the health and welfare of the workers. These provisions were as follows:

1. The maximum concentrations of hazardous gases allowable in the tunnel atmosphere were as follows: methane, 0.5 percent; carbon monoxide, 0.01 percent; carbon dioxide, 0.1 percent; oxides of nitrogen, 0.0025 percent; hydrogen sulfide, 0.002 percent; sulfur dioxide, 0.001 percent. The oxygen content was not allowed to fall below 14 percent.

2. The concentration of free silica dust in the tunnel atmosphere was not to exceed 5,000,000 particles per cu ft (ppcf) of air. Wet drilling and continuous wetting down of the muck pile during mucking were required.

3. A ventilation plant with a minimum capacity of 20,000 cfm was required. This system was operated around the clock six working days a week, and for at least two hours before the resumption of work on Monday. In addition, the fire boss checked the air for explosive gases before any one else entered the tunnel on Monday morning, and routinely while the tunnel was occupied.

4. A preemployment physical examination was required. Applicants showing evidence of silicosis and those who, in the judgment of the examining physician, had any pulmonary condition which would be aggravated by the environmental conditions in the tunnel, were rejected for underground work.

5. The contractor was required to have a qualified professional engineer to act as safety engineer.

6. The contractor was required to employ on each shift a fire boss certified by the West Virginia State Department of Mines. He checked routinely for methane, carbon monoxide, and oxygen deficiency and also acted as a general safety inspector.

7. The contractor was required to carry workmen's compensation insurance with the West Virginia Workmen's Compensation Commission.

Throughout the time that the tunnel was being driven, the Bureau of Industrial Hygiene, West Virginia State Department of Health, made routine checks of the atmosphere in the tunnel. Samples were taken once each week from May 25 until September 30, 1953. Samples were taken each week for dust counting, free silica analysis, carbon monoxide, oxides of nitrogen, and aldehydes. Samples were taken occasionally for sulfur dioxide, hydrogen sulfide, oxygen, and carbon dioxide. Aldehydes were checked because diesel-powered equipment was used underground.

Test drilling indicated a high free silica content in the rock to be removed, and later tests showed that the free silica content averaged 54 percent. The rock was primarily sandstone, with an intermixture of small amounts of mica, silica-bearing shale, and occasional narrow seams of coal.

Drilling. Drilling was done from a conventional jumbo on which were mounted 13 drifter-type pneumatic drills on four levels. The holes drilled ranged in diameter from $1^7/_8$ to $2^3/_8$ in., and at different times the depth drilled ranged from 7 to 13 ft. Each drill required about 0.5 gal per min of water. On the average, 128 full-length and 29 half-length plug holes were drilled on each round. Drilling required from $2^1/_2$ to $3^1/_2$ hours on each round, depending on the depth of the holes drilled.

Shooting. As soon as drilling was completed, the holes were loaded (with about 2.8 lb of 40 percent dynamite per cu yd of rock shot down); the jumbo was moved back about 125 ft; all workmen were moved to the outside; and the shot was fired. Depending on the depth drilled, from 235 to 415 cu yd of rock was shot down. The shot produced muck of a size convenient for handling by a 2-cu yd diesel shovel. The muck was relatively free of fines.

Mucking. About one-half hour after the shot, the foreman and the fire boss proceeded to the heading to make an inspection; then mucking started. A bulldozer was used to clean up muck thrown away from the heading by the blast, and a 2-cu yd diesel shovel loaded the muck into diesel-powered LeTourneau Tournarockers, which hauled it to the outside for disposal. Three to four Tournarockers were used.

After mucking was finished, the jumbo was towed to the heading, steel

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roof supports were set, and the cycle was repeated. The length of cycles varied from about 8 to 15 hours, again depending on the depth of the holes drilled and consequently the amount of rock blasted down. Average progress in driving the tunnel was about 20 ft a day, six days a week.

Ordinarily about 30 to 35 men were at or near the heading during most of each shift. During the day shift there were a few more than that, including those there part of the time, such as electricians, and laborers extending ventilation pipe, water and air lines. Drilling took about one-fourth, and mucking one-third, of the eight-hour shift. The balance of the shift was spent on work which caused little or no air contamination.

Initially a No. 2 fuel was used in the diesel equipment which operated underground. The concentration of exhaust products resulted in some eye irritation, described by different observers as slight to moderate. As a result, the Bureau suggested that underground equipment be operated on No. 1 fuel. This change was made, and thereafter eye irritation was seldom noticed.

The dynamite used initially was a "redipped" type. About half way through the job a change was made to a "sprayed" type. There appeared to be less fume produced by the sprayed dynamite, although as the tunnel progressed there was increased time for fumes to become diluted with the air delivered to the heading before being exhausted to the outside. In addition, a smaller shot was employed during the latter period; thus less fume was produced. There was much less paraffin on the sprayed type to add to the fumes resulting from the dynamite itself. All dynamite was of a type acceptable for underground use.

The ventilation system was installed with the blower and motor outside, near the portal, with a 26-in.-diameter steel tube delivering the air to the heading. The outlet of the tube was kept as close to the heading as possible while avoiding damage by blasting, ordinarily within 120 ft of it. The velocity of the air as it left the pipe was sufficient to sweep out dead spaces at the heading and remove all dust and fumes.

Immediatedly after shooting, air was exhausted from the heading to remove the worst of the fumes and dust. Then, after several minutes, the flow of air was reversed, and fresh air was delivered to the heading until time for the next shot.

The drills supplied about 3,000 cfm of air to the heading during the time they were in operation. This was in addition to that supplied by the ventilation system.

The amounts of various contaminants here reported are representative of the samples taken. Initially most samples were taken at or near the heading, as there were usually no workers in the tunnel except those near the heading. Later, as other work progressed, samples were taken at various locations from the portal to the heading. The total number of samples taken for various contaminants was as follows: dust counts, 143; free silica analysis, 34; carbon monoxide, 49; oxides of nitrogen, 78; oxygen and carbon dioxide, 34; sulfur dioxide, 18; hydrogen sulfide, 5; aldehydes, 64, and partially burned fuel, 7.

Dust and free silica during mucking. During mucking operations samples for dust counting were usually taken: (1) at the heading ahead of the mucking shovel, (2) just behind the mucking shovel, (3) on the bottom near the jumbo, and (4) on top of the jumbo. These were the areas where the most workers were ordinarily located. The samples taken at the jumbo location (usually about 125 ft from actual mucking operations) showed no significant difference from those taken near the shovel at the heading, and there was ordinarily no significant difference between those taken on top of the jumbo and those taken near its bottom. This indicates that the dust produced in mucking operations was rapidly dispersed throughout all available space. The lowest dust count was 4,500,000 ppcf, while the highest count was 32,000,000 ppcf. Ordinarily the average amount of dust varied from 8,000,000 to 17,000,000 ppcf. The single high count of 32,000,000 ppcf was found at a time when the water was not being properly used on the muck pile.

During mucking operations, samples of air-borne dust were taken with the Staplex air sampler fitted with the conventional pleated type TFA-S filter. These samples were analyzed for free silica. The percentage of free silica found in the air was relatively constant, varying from a low of 25 percent to a high of 37 percent, and averaging about 31 percent. Several analyses of the rock itself indicated a high free silica content averaging about 54 percent. Thus the free silica content of the air-borne dust was considerably lower than that of the rock from which it came.

Vehicular activity in the tunnel caused no dust, as the bottom was wet at all times—due to the large quantity of water used at the heading.

Dust and free silica during drilling. During drilling operations, samples were also taken for dust counting, again accompanied by collection of air-borne dust for free silica determination. Samples were taken in the breathing zone of drillers and helpers at various locations on the jumbo. Dust counts ran from 1,000,000 to about 6,000,000 ppcf and averaged about 3,000,000 ppcf. The free silica content of this dust was the same as that collected during mucking.

Carbon monoxide. Carbon monoxide was checked with the M.S.A. (Mine Safety Appliances Company) colorimetric detector. The fire boss also made routine checks with the same type of instrument. Sources of CO were from the dynamite, diesel motors, and gasoline-powered trucks used in maintenance and supply operations. The gasoline-powered trucks were not too important a factor, owing to the limited time they were in the tunnel. The fire boss regularly took a CO sample when he reached the heading for his inspection after blasting. The amount normally found was in the range from none to 50 ppm of air. We also occasionally entered the tunnel with the fire boss, and our sampling confirmed his results.

A large quantity of carbon monoxide was produced from the dynamite, but the ventilation air diluted it considerably. The highest reading obtained in what appeared to be the worst of the blasting fume was 200 ppm. The highest concentration found soon passed any one point in the tunnel. Within a half hour after the highest amount was found (200 ppm in this case), the concentration had dropped to 50 ppm and a half hour later to less than 25 ppm. It should be remembered that throughout this period muck-hauling vehicles were operating; yet approximately two hours after the shot the carbon monoxide concentration was very low. This rapid fall in the CO concentration was typical of other series of measurements made in the same manner and indicates that the quantity of CO present in the diesel exhaust was of little or no hygienic significance after dilution with the air supplied by the ventilation system.

Oxides of nitrogen. There were two possible sources of oxides of nitrogen—dynamite fumes and diesel engines. Samples were taken in what appeared to be the worst of the fume from blasting and at various locations throughout the time that mucking was in progress.

The concentration pattern for oxide of nitrogen was similar to that found for carbon monoxide. The highest concentrations, 50 to 75 ppm, were

found in the fume from the dynamite, and as the fume passed a particular point the concentration fell rapidly to 4 to 8 ppm. During the period when a smaller amount of dynamite was used, the maximum concentration of oxides of nitrogen fell considerably.

At times when fumes from dynamite were not present, but during the time that mucking was in progress, the concentration of oxides of nitrogen was usually in the range of 4 to 8 ppm. Occasional samples taken at times when there were no dynamite or diesel fumes gave negative results.

Oxygen and carbon dioxide. The oxygen content of the air, as measured at points throughout the tunnel, never fell appreciably, usually being 20.7 to 20.8 percent. Carbon dioxide seldom exceeded 0.1 percent and was usually less then 0.1 percent.

Aldehydes. Since aldehydes are produced in diesel engines in the combustion process, samples for aldehyde determination were taken while mucking was in progress. Results are expressed as equivalent parts per million (ppm) of formaldehyde. Here again, as in the case of other gases, series of samples were taken at various locations in the tunnel and near the heading. During mucking there were ordinarily two or three diesels at the heading—the mucking shovel and one or two muck-hauling vehicles.

Concentration of aldehydes usually did not vary appreciably at different sampling locations. Inasmuch as aldehyde samples were taken at approximately the same time as those for carbon monoxide and oxides of nitrogen; many were taken in the blasting fume. No general decrease in aldehyde concentration occurred after this fume passed, as was the case with carbon monoxide and oxides of nitrogen, indicating that diesel fumes were the primary source of aldehydes.

The concentration of aldehydes from the diesel engines was about 0.6 to 0.8 ppm. Samples were taken occasionally when no diesels were operating, and in these no aldehydes were detected.

Sulfur dioxide. The sulfur content of the diesel fuel used was known to be very low, and significant amounts of sulfur dioxide were not expected. The samples taken confirmed that sulfur dioxide was not present in quantities of hygienic significance.

Hydrogen sulfide. The possibility of the presence of hydrogen sulfide was recognized because of the action of water on coal containing sulfides. However, none was detected with the use of the M.S.A. Hydrogen Sulfide Detector, nor was the odor of hydrogen sulfide ever noticed.

Partially burned fuel and soot. Samples containing partially burned fuel and soot are being subjected to infra-red spectrographic analysis in an effort to generally identify their chemical composition. At this writing the results are not available.

An industrial hygienist working at the heading experienced severe ringing in the ears and partial deafness lasting several days after a few hours' exposure to noise during drilling. Suitable earplugs were obtained and no further discomfort was noticed. Drillers stated that they became accustomed to the noise, but it seems likely that damage to hearing could result from exposure over a long period of time. Suitable instruments for complete noise analysis were not available, but a few readings taken with a noise-level meter indicated that the overall level exceeded 110 decibels. Drillers follow this type of work about the country, so their exposure ordinarily is of many years' duration.

Conclusions summarized

1. Wet drilling, generous use of water during mucking, and the ventilation system used kept the dust concentration within acceptable limits.

2. The ventilation system was adequate for dilution and removal of fumes and gases from shooting and oxides of nitrogen from diesel engines, but at times it was inadequate for removal of unburned and partially burned fuel. Employment of an auxiliary fan of similar capacity, and used along with the one operated, would have supplied adequate ventilation under all conditions and would have cleared the heading much sooner after shooting, thus allowing workmen to return sooner. The second unit need operate only from immediately after the shot until diesel fumes from mucking are exhausted. This would also allow for more frequent inspection and maintenance of ventilation equipment, thus reducing the likelihood of breakdowns. The time saved would largely offset cost of an additional unit.

3. Carbon monoxide from diesel engines was not present in the tunnel atmosphere in significant amounts.

4. The oxygen content of the air in the tunnel was adequate; carbon dioxide was not a problem.

5. Sulfur dioxide (from the fuel) was not encountered in significant amounts.

6. Methane and hydrogen sulfide were not detected.

7. The eye irritation is believed to have been due to unburned or partially burned fuel, although low concentrations of aldehydes may have been a factor.

8. There is probably less fume produced from the sprayed than from the redipped dynamite.

9. The noise level was probably high enough to be damaging after an exposure period of several years.

Recommendations for tunneling

1. Contract provision. Provisions in contracts covering health and welfare should be spelled out in detail, as was done here. In this way the contractor knows prior to the undertaking just what standards are to be met.

2. Control of dust. Wet drilling and continuous wetting of muck are necessary. Production of a large amount of fines in the muck caused by shooting can and should be avoided.

3. Ventilation. If diesel-powered equipment is to be used safely in confined areas, the calculations for ventilation must take this into consideration. One method of calculation recommends that the minimum ventilation air supplied where diesels are used in confined areas should be 25 to 50 times the piston displacement at maximum rated speed. On the basis of our experience, this is a sound recommendation.

4. Operation of diesel equipment in confined areas. No. 1 fuel oil should be used, as low-boiling fuels vaporize more readily and burn more completely. Equipment must be maintained in good mechanical condition, and air-filter equipment must receive special attention where dust is present, as satisfactory combustion is attainable only when uncontaminated air is introduced into the engine. Injectors should be adjusted so that combustion takes place in excess air, and the air-fuel ratio should be 20:1, or leaner. The operator should take the throttle up gradually after an idling period in order to burn the excess fuel in the combustion chamber with excess air.

5. Explosives. Explosives should be of a type approved for underground use. Sprayed dynamite should be used.

6. Noise. Suitable earplugs, available from safety equipment manufacturers, should be used by drillers, helpers, and others who habitually work near the heading during drilling.

7. Air sampling. Air sampling should be done often enough to assure that proper standards are maintained.

Paul D. Halley, Industrial Hygienist, Standard Oil Company of Indiana, Chicago, formerly Associate Director of this Bureau, and E. V. Jones, M. ASCE, Resident Engineer, Howard, Needles, Tammen and Bergendoff, offered many helpful suggestions during the course of this work and critically reviewed the manuscript.

CLEMENT J. FREUND, Dean of Engineering, University of Detroit, Detroit, Mich.

Employers, ethics, and young engineers

Not long ago a recent engineering graduate was in my office to tell me his troubles. He was two years out of college and as far as I could see was making good progress at his job in one of our Detroit automobile manufacturing corporations. He had something to do with the development and redesign of the combustion area above pistons. Nevertheless he was restless and dissatisfied. He thought he ought to resign and look somewhere else. This interview was a familiar experience. It seems that a great many of our engineering graduates are discontented and unhappy.

I could not help comparing this recent engineering graduate with a young physician of my acquaintance who is an interne in a hospital near my home. The young physician studied eight years following high school, the young engineer four years. The physician spent about $10,000 in tuition and fees (or his parents did), the engineer about $2,500. The physician has impossible working hours; he is on call day and night. The engineer works an easy forty hours per week.

The physician is married but lives at the hospital. He gets his meals there although he has an occasional day off. The engineer lives pleasantly with his wife and small son in a five-room apartment. The physician is paid $1,200 a year and his keep; the engineer was paid $4,600 a year when he graduated, and he is getting more than that now. The physician is contented with his rugged and meager assignment; the engineer is sitting on top of the world and is dissatisfied.

Obviously the young interne has something which the engineer does not have. The engineer has an immense advantage over the interne in every respect except for that something. That something makes the young interne happy with his lot, while the engineer is clearly unhappy. I know both young men very well. I have studied the attitudes and mode of life of each. I believe I know the secret of the interne's peace of soul. He has professional standing.

The interne is a member of a great profession; he is proud of it and happy about it. The engineer may belong to a profession some day but he is not sure. Certainly he does not think much either of his profession or about it.

The interne is respected. He enjoys all the strictly professional privileges of the oldest surgeon on the staff. He has the title of doctor, and all in the hospital address him as such. He has authority over nurses, attendants and other employees, many of them twice his age. Nobody in the hospital may openly question his medical judgment except senior physicians and surgeons. Patients do not know the difference between him and the younger men on the regular medical staff.

The engineer, on the other hand, is just another employee, no different from thousands of toolmakers, assembly men, clerks, and draftsmen. He has authority over nobody. He is a college trained engineer but, except for personnel officials, nobody knows it and nobody cares.

What has all this to do with engineering ethics? A great deal, it seems to me. Many employers are worried about the Engineers and Scientists of America. This is the union, as most engineers know, which is currently attempting to enroll employed engineers. Other unions have tried, and none has achieved more than an ambitious start. But the succession of failures is small consolation to nervous engineering employers. This union might succeed.

Employers, of course, do recognize technical ability and competence in engineering. But technical ability and competence are not the sum total of professional standing. Professional standing is made up of two elements—technical competence and training, plus high honor and integrity, or ethics. Engineering employers, it seems to me, ought to be as much concerned about the ethical standards of engineer employees as they are about their technical education and ability. It would be interesting to inquire of the seniors of any university who were interviewed by employers this year if a single one of them was asked by any interviewer what he knows about the ECPD code of engineering ethics, or about the code of the American Society of Civil Engineers. Not a single hand would be raised in answer to the question.

When engineering employers habitually and regularly insist that engineers shall know their ethics, just as they insist that engineers shall be technically competent, they will have gone a long way toward giving engineers professional standing. Then, and not until then, will engineers enjoy the professional standing of physicians and lawyers in the employ of corporations.

Once the employer has given his employees full professional standing he will not need to worry about any engineering union. If the employer will give his engineer employees the personal privileges that go with professional status, he will have no union problem in his engineering staff, and few personnel problems of any kind. Unions do not try to organize clearly professional people when they are known to be professional. I am not opposed to labor unions in their proper function, and when they are decently and legally managed. But I am most emphatically opposed to labor unions in medicine, in law, in the ministry, and in professional engineering.

We engineering educators must face up to our responsibilities. In the past, we have taught young engineers to be reasonably competent in technology; but we have told them very little about engineering ethics, and it is high time for us to mend our ways.

(This article is an abstract of Dean Freund's address before the Division on Relations with Industry of the American Society for Engineering Education, at the University of Illinois, Urbana, Ill., in June 1954.)

PRESTRESSED CONCRETE

takes 8,000-ton press at half the cost of

An 8,000-ton forging press recently completed in Cleveland, Ohio, posed a knotty foundation problem because of limited foundation width and an allowable soil bearing load of 3,200 psf. The press is part of the "Heavy Press Facilities" program recently instituted by the U.S. Air Force to speed production of aircraft. The Aluminum Company of America is responsible for furnishing plant and facilities for one extrusion press and four forging presses. In the Lafayette, Ind., works, the 14,000-ton Schloemann extrusion press, about which there has been considerable publicity, has been installed and placed in production. At the Cleveland, Ohio, works, a 15,000-ton forging press has been installed and is in operation, and provisions are being made for three additional forging presses with capacities of 8,000, 35,000, and 50,000 tons respectively.

The foundation for the 8,000-ton forging press, which has been completed, presented a challenging engineering problem. Because of space limitations and soil bearing values, the final design is a departure from the more conventional types of heavy equipment foundations and is, so far as known, the first prestressed-concrete soil-bearing foundation to be built in the United States.

The agreement under which this press is being built provides that it be placed in an existing building. To make this possible, the building had to be completely remodeled so as to provide ample height for the press and also accommodate a 100-ton industrial service crane.

Reconstruction of the building was completed as early as possible in order to enclose the area. To protect the

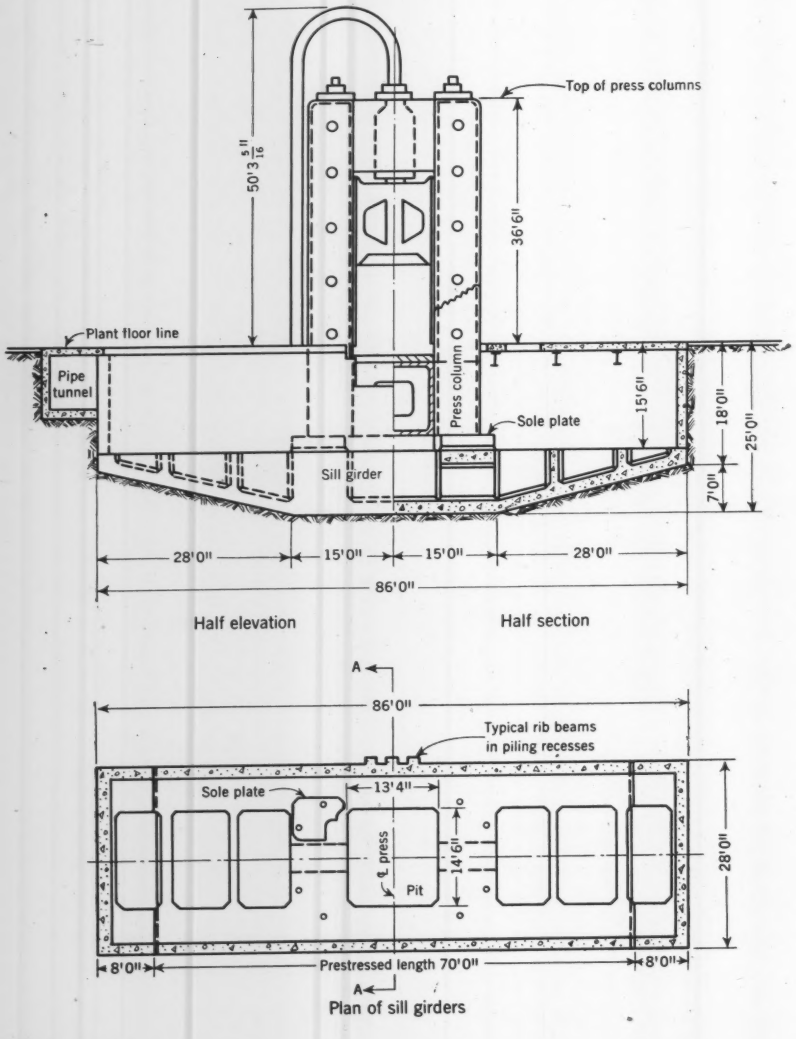
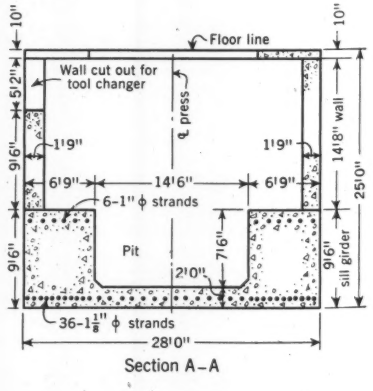


FIG. 1. Sill girder is prestressed for 70 ft of its 86-ft length. Girder is tapered toward ends to reduce foundation weight, as seen in cross section at left.

FIG. 2. Width of foundation was limited to 28 ft by sheetpiling placed to protect column footings of existing building. Sidewalls on sill girder are tied to it, making the whole act as a composite beam section.



FOUNDATION

conventional design

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This article is from a thesis presented to Carnegie Institute of Technology, in partial requirement for the degree of Civil Engineer.

column footings of the building and the foundation areas of adjoining structures from undercutting, it was necessary to drive a steel sheetpile cutoff of section MZ38 around the press foundation. The cell was excavated and a concrete work mat 3 in. thick was placed in the bottom. The piling was left in place when the foundation was built.

Allowing for two rows of piling and the footing clearance, a net width of only 28 ft was left for the press foundation. In the longitudinal direction, along the aisle, there was no space limitation, except that the foundation should not be too long to properly distribute the loads to the soil.

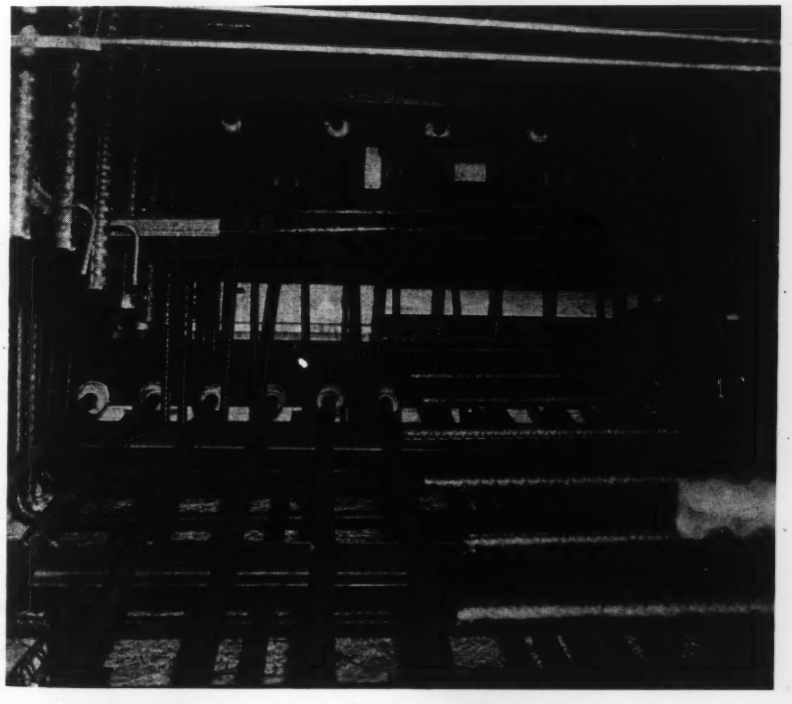
Another condition that imposed a limitation was the allowable bearing value of the foundation material. The soil underlying the press has a layered structure, and is composed of dark gray silt with layers of gray silty clay and fine sandy silt extending for a depth of 130 ft below floor level before hardpan is reached. Drainage in the area is good and there is no ground-water problem.

Tests conducted at the time the 15,000-ton press was installed, indicated that this material could carry up to 3,400 psf without critical settlement. The maximum foundation pressure for that design was 3,145 psf, and although a small amount of the anticipated settlement did take place, the greater part of it occurred during the placing of the foundation concrete, which was 60 percent of the total load on the soil. Since the former design loads had proved satisfactory, it was decided to use a maximum allowable soil pressure of 3,200 psf for the current installation. The design weight of the 8,000-ton press is 2,300 tons.

The physical dimensions of the press established that the bottom of the 18-in-thick sole plates should be 15 ft 2 in. below the plant floor level. With an allowance of 4 in. for grouting, the top of the supporting sills is 15 ft 6 in. below floor level (Fig. 1). It was also necessary to provide a pit under the press for access. This pit measures 13 ft 4 in. lengthwise of the foundation by 14 ft 6 in. across the foundation, and has a depth of 7 ft 6 in. below the top of the sills (Fig. 2). This leaves, on each side of the 28-ft wide foundation, a rectangular section 6 ft 9 in. wide by 7 ft 6 in. deep, establishing what might be called the basic foundation superstructure. Below the bottom of the pit, which is 23 ft below floor level, it was therefore necessary to add a depth of concrete suitable to the type of foundation employed. It is obvious that the greater the depth of this part of the foundation, the less efficient the foundation becomes as a supporting medium.

Studies were made of several different types of foundations, taking into consideration the limiting conditions. The first arrangement considered was to support the foundation on a cluster of bearing piles, and it was estimated that the weight of the concrete and press would require a cluster of approximately 120 piles. The nature of the soil made it impossible for the piles to carry any appreciable load until driven to point bearing on hardpan, which meant about 100 ft of driving per pile. Even using the pile cluster, it would have been necessary to design the masonry so as to distribute the concentrated press loads over a considerable area. It was estimated that this pile-cap foundation would effect a saving in concrete over a spread soil-bearing foundation, but that the additional cost of the pile cluster would offset this saving.

The customary type of foundation employed for this kind of installation is a heavy reinforced concrete mat on which the foundation superstructure is placed. Ordinarily the mat type of foundation



View inside of one of sill girders at jacking end shows all strands and reinforcing in place ready for concreting. Sill girders are 6 ft 9 in. wide by 4 ft 6 in. deep at ends of prestressed section. Wall steel is shown anchored into beam at upper left. Top-slab transverse steel runs well into sill girder at lower right.

is estimated to weigh approximately 175 percent of the weight of the equipment it carries, so that its inherent weight utilizes about two-thirds of the allowable bearing value of the soil. A preliminary design was made of this type of foundation to determine the bearing area that would be required to distribute the weight of the press. This area was found to be 28 ft × 134 ft. Such a foundation would weigh about 7,800,000 lb, or 168 percent of the weight of the press. If the allowable soil pressure is 3,200 psf, the concrete foundation would contribute 2,010 psf, or 62.5 percent of the total. This type of foundation would have required about 1,925 cu yd of concrete.

In addition to the large volume of material in this foundation, another objection was the uncertainty of attaining approximately uniform bearing pressures throughout its length, because of the deflection occurring at full load moment.

The alternative to a mat-type foundation would be a slab type of absolutely minimum dimensions and weight. Such a design could be developed by using the two beams, one on each side of the press pit, to provide the flexural strength by prestressing these beams before constructing the rest of the superstructure. These beams, termed the basic foundation superstructure, are 7 ft 6 in. deep from the top of the sill to the bottom of the pit and 6 ft 9 in. wide. It was estimated that a 24-in. slab under the pit would be ample to take care of the soil pressures encountered there. By extending this slab for the full width of the foundation, the two beams become 9 ft 6 in. deep with a bottom connecting slab 2 ft thick. In view of the requirements of the press, this was the minimum section of foundation that could be achieved. However, with such a large cross-sectional area of concrete, it was possible to develop a tremendous moment by the use of post-tensioning strands.

This prestressed section is called the sill girder, and the maximum 9-ft 6-in. depth is continued under the press for 15 ft on each side of the center line. Then, in order to lighten the foundation, the bottom was raised on a 1 to 4 slope, so that the weight per foot of the sill girder at the ends of the foundation is only 40 percent of that at its maximum section under the press.

The 21-in.-thick side walls on top of the sill girder run the full length of the foundation and are 14 ft 8 in. high, except for one cutout in the south wall which accommodates the tool-changer mechanism. These walls are tied and keyed to the prestressed sill girder to make sure that they will act as an integral part of the composite beam section. Since the walls are in compression, the vertical recesses in the piling, which are outside the walls, are reinforced and utilized as rib beams to provide stiffness against lateral inward deflection of the top of the walls. The piling reinforcing consists of vertical tension steel at the outside face of the recesses and ties into the wall.

The weight of this foundation structure is 3,285,000 lb, or only 71 percent of the weight of the press. The soil pressure caused by the combined weight of concrete and press is 3,140 psf. The portion contributed by the concrete alone is 1,300 psf, or only 41.5 percent of the total allowable soil pressure.

This prestressed concrete foundation requires about 810 cu yd of concrete, or approximately 42 percent of the 1,925 cu yd that would have been required for the mat foundation. Even with the additional cost of the post-tensioning strands, this prestressed design effects approximately a 50-percent saving in foundation cost.

Strand arrangement

The beam section available for moment resistance is composed of the prestressed sill girder and the subsequently constructed unstressed side-walls. This beam was treated as a homogeneous unit in which there would be sufficient prestress to maintain the entire section in compression under full load.

The maximum unit tensile stress at the bottom of the foundation due to bending is 190 psi, a very low value because of the large mass of concrete. Prestressing provides a compressive unit stress of 250 psi, thus giving a residual compressive stress of 60 psi when the foundation is under full press load.

To meet the required top-strand load of 648,000 lb, twelve strands of 1-in. diameter, six in each beam, with an area of 0.577 sq in. per strand, were used. The design load is 54,000 lb per strand, or 93,600 psi.

For the bottom-strand load of 2,534,000 lb, it was necessary to use 36 strands of $1^1/_8$-in. diameter, with an area of 0.751 sq in. per strand. These bottom strands were apportioned 22 to the bottom of the two beams and 14 in the slab. The 22 strands in the beams have a design load of 70,000 lb per strand (about 93,200 psi), and the 14 strands in the slab have a design load of 71,000 lb per strand (about 94,500 psi).

The highest initial unit stress of 113,180 psi is about half of the ultimate of the strand and was purposely kept to this level to minimize the amount of strand losses.

Strands were furnished galvanized, with end fittings attached, by the John A. Roebling's Sons Corp., and were sheathed with flexible metal tubing which completely covered the strands.

The end forms for the prestressed sill girder were accurately set and anchored to the piling so that it was possible to place the strands in exact position with the nuts in place on the fittings at both ends. The length of the strands was established in such a way that the full elongation could be obtained at the jacking end and, if necessary or desirable, one-half of the elongation could be obtained at the fixed or non-jacking end.

Under a previous contract, the Sam W. Emerson Co. of Cleveland built the accumulator pit for this press installation, and drove steel sheetpiling around the press foundation to the neat lines of the concrete. The foundation was excavated and a concrete work mat 3 in. thick was placed to grade. The contract for the press foundation, pipe tunnel, and appurtenant foundations was awarded to the same contractor.

In building the press foundation, the 70-ft prestressed length of the sill girder was built first. The two-way mat of reinforcing in the bottom of the foundation was placed and supported on the work mat, and the supports for the bottom strands were located and set to grade. After the end forms had been accurately placed and anchored, the strands were put in place and positioned at the jacking end, and the tubing was stretched out to the fittings. The strands were then wired to their supports, after which the pipe sleeves at the ends were calked.

After the basic reinforcing had been placed for the rest of the sill girder, the supports for the top strands were placed and these strands were installed in the same manner as the bottom strands.

The concrete in the sill girder was placed in one continuous operation—520 cu yd of 4,000-psi concrete with a maximum $2^1/_2$-in. slump. The concrete was cured with the forms in place for 9 days in order to insure a minimum concrete strength of 3,000 psi, and then the forms were stripped for tensioning.

The tensioning procedure followed was to make four passes across the foundation. On each pass every fourth bottom strand was loaded, but on the first three passes, every third top strand was loaded.

The first pass actually started in the center of the foundation, working alternately to the sides so that no tensile stresses would be set up at the sides of the foundation. The top strands on each pass were tensioned after the bottom strands had been loaded below them, so that at no time were any tensile stresses set up in the bottom of the concrete.

Tests were run on each size of strand by the supplier. From the stress-strain curves obtained, the elongations were computed for the required strand loads. When the strands were tensioned, the loads were checked both by gage reading on the pump and by elongation.

The top strands, being straight, pulled up to the desired elongation with the required gage load. The bottom strands, however, were curved at two points and because of the friction induced, had to be overloaded to obtain the necessary elongation. After all strands had been tensioned, they were allowed to stand and then were tensioned again to the specified loads. The tensioning was accomplished from the jacking end only, and the final elongations indicated a loss of about 6 percent of the initial loads.

With the post-tensioning completed, the two 8-ft end sections of the sill girder were concreted. After these had been cured, the wales and struts were removed from the piling cell and the concrete in the walls was placed.

Now that the installation of the press has been completed, the foundation appears to be satisfactory in every respect. A preliminary check showed no appreciable settlement, and only the slight deflection anticipated for the large composite beam.

Necessity provokes progress

Again, as in the past, "necessity" has led to a departure from a conventional method of design and to adoption of a new adaptation of engineering principles. There were three factors that prompted consideration of the prestressed design in this case: (1) the limited space, permitting a foundation width of only 28 ft; (2) the maximum design soil pressure of 3,200 psf; and (3) the heavy press, weighing 2,300 tons and occupying a floor space of 25 by 14 ft, less than 360 sq ft.

The prestressed design met these conditions and provided an admirable solution to the problem. Weighing only 42 percent as much as a mat foundation, the prestressed foundation was capable of carrying the total weight of press and foundation at 3,200 psf on the soil, in a length of only 86 ft, or three times its width.

In addition to its ready adaptability to meet varying conditions, the prestressed design has another very attractive feature, that of economy. Including the cost of post-tensioning strands, it was built for less than half the cost of a conventional type of foundation.

Although this is the first known use of prestressing in a heavy soil-bearing foundation design, the method has the potential qualifications for a wide and effective use in this field of engineering.

Jack has almost completed first stroke of 2½ in., after which nut will be tightened and jack reset to complete required strand elongation of 3.6 in. Capacity of jack is 100 tons.

Jacking end of one beam of sill girder is seen after post-tensioning has been completed. Next, unstressed end section of sill girder will be poured against prestressed ends, so that strand fittings and reinforcing shown will be completely embedded in concrete of end section.

E. O. MARTINSON

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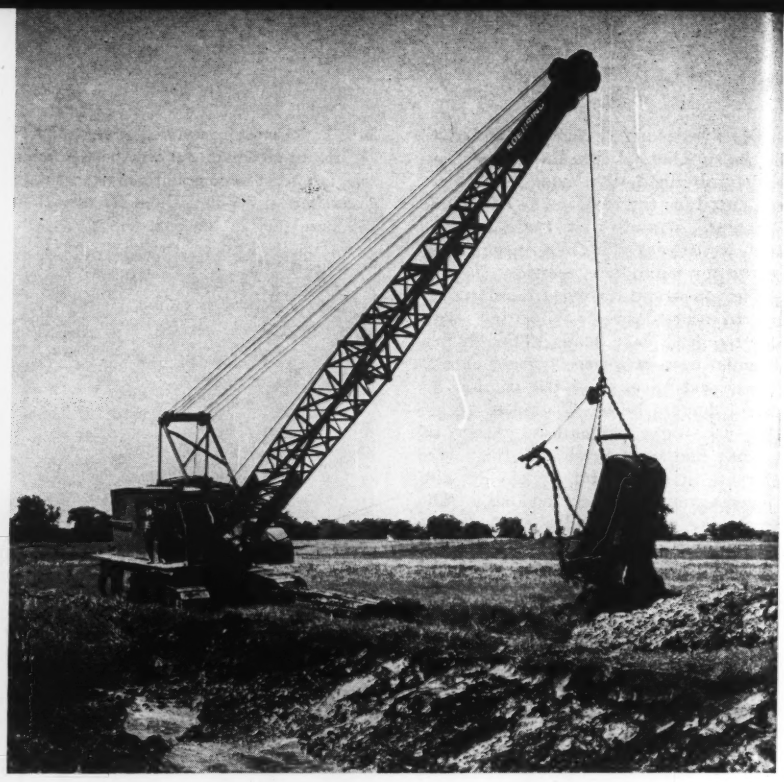
Brantford, Ontario, Canada



INFORMATION on equipment performance and first cost was given graphically in Mr. Martinson's first article, in the December 1954 issue. This second article, on operating costs, completes his set of graphs and explanatory text prepared as a guide for the quick selection of power cranes and shovels to suit specific job conditions.

POWER CRANES AND SHOVELS

Quick selection by charts and graphs

II. Operating costs

After the hourly outputs of the various sizes of machines have been determined, it is possible to determine the cost per cubic yard excavated for several classes of material and for various operating efficiencies. The operating cost consists of three major items: (1) fixed machine costs such as depreciation, interest, and taxes, which accrue whether a machine is used or not; (2) variable machine costs such as fuel, repairs, and supplies, which are incurred only when the machine is operating; (3) labor, including operator, oiler, supervision, and payroll expenses like social security, unemployment tax, workmen's compensation, vacation pay, and other fringe benefits.

Fixed operating costs

The annual fixed costs of the machine depend mostly on its original cost less its resale value at the end of the depreciation period, and the rate at which it depreciates. The average factory price of diesel-powered shovels is given in Fig. 10 as in Fig. 1, but Fig. 10 adds the average freight at a 1,000-mile distance to show a typical delivered cost. An estimated minimum resale value at the end of the standard depreciation period is also given. For example, the chart indicates that a $1^1/_2$-cu yd shovel costs around $40,000 new, delivered; and at the end of a six-year period, or after 12,000 hours of use, it might have a resale value on a trade-in of say $12,000. If a longer depreciation period is used in computing costs, the resale value would be less but so would the annual depreciation cost, and one would largely offset the other. In this analysis the minimum allowable depreciation time will be used in computing operating costs.

The several items which make up the annual fixed cost of shovels and draglines are shown in Fig. 11. The minimum depreciation periods for one-shift operation allowed for shovels and for draglines by the U. S. Treasury Department for income tax computation as of two or three years ago are listed at the bottom of the graph. The recent tax law revision may change these periods. Annual fixed costs are made up of taxes and insurance plus interest on the average investment during the life of the machine, which in this case is taken as the depreciation period, plus the annual depreciation of the dragline or of the shovel. The top line on the chart is the total of taxes, insurance, interest, and depreciation for shovels, which is higher than the next line below it, which is the total for draglines, because the depreciation period for a dragline is longer than the minimum allowable time for shovels.

The annual fixed costs can be converted into hourly fixed costs for various average hours of operation per year. In Fig. 12, the hourly fixed cost of ownership for both draglines and shovels is given for averages of 500, 1,000, 2,000, 4,000 and 6,000 hours per year. This

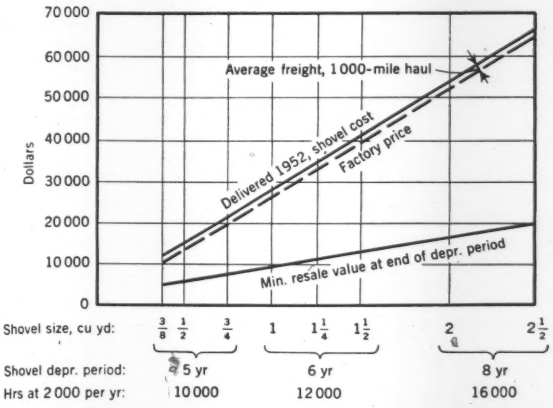


FIG. 10. Resale value at end of depreciation period is compared with new delivered price of diesel-powered shovel in eight sizes. Price is average for several manufacturers, assuming a 1,000-mile freight haul. Cost of cranes and draglines is about 90 percent that of shovels.

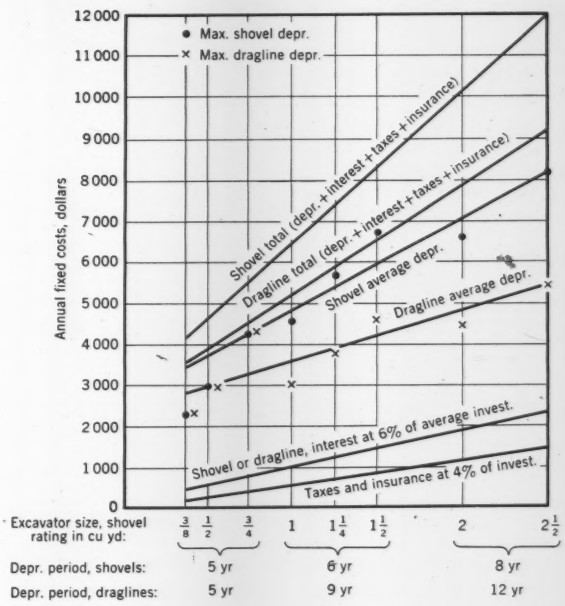


FIG. 11. Annual fixed costs are plotted for eight sizes of shovels and draglines. Depreciation is taken as average maximum rate allowed by U. S. Treasury Department for use in income tax statements, for one-shift operation.

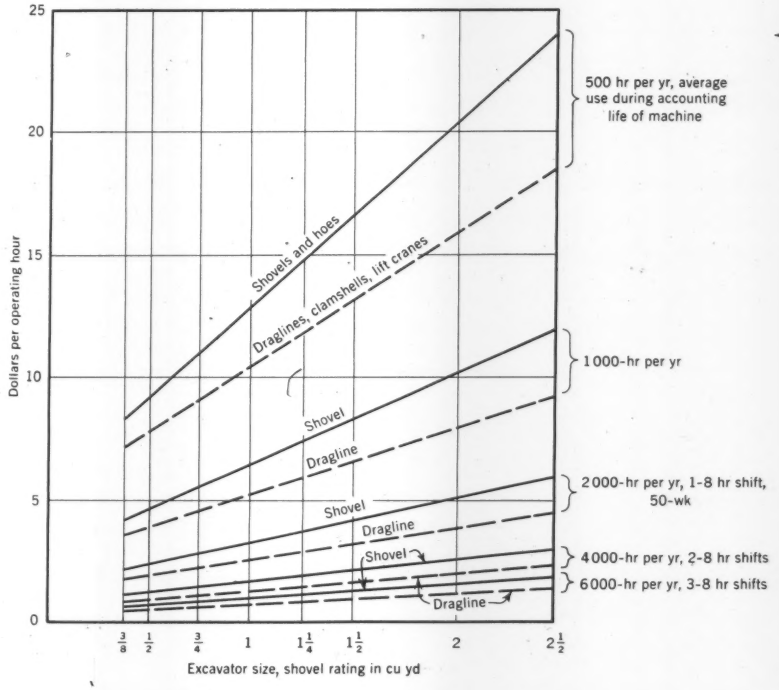


FIG. 12. Maximum fixed hourly machine costs for excavators here plotted include depreciation (at maximum rate allowed by U. S. Treasury Department), plus interest, taxes and insurance at 10 percent of average investment after depreciation. Effect of number of hours of use on hourly fixed cost is shown. Same depreciation rate is assumed for three-shift as for one-shift operation.

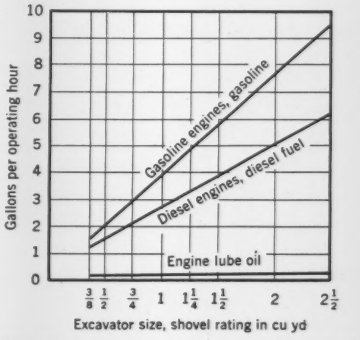


FIG. 13. Consumption of engine fuel and lubricating oil (a variable cost) is plotted in gallons per operating hour for average excavator service according to shovel size.

chart merely shows how widely the fixed costs can vary, depending upon the hours per year that a machine is used. Here again depreciation is figured at the maximum rate allowed by the U. S. Treasury Department for income tax purposes. Interest, taxes and insurance are taken at 10 percent of the average investment after depreciation.

The variable cost of operating a machine is next determined. Variable costs are incurred only when the machine is in operation. Fuel and lubricating oil make up one of the variable costs of operation. Figure 13 shows es-

FIG. 14. Cost per operating hour is plotted for engine fuel and lubricating oil according to shovel sizes, based on average fuel prices.

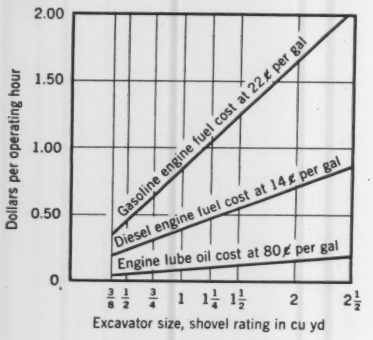
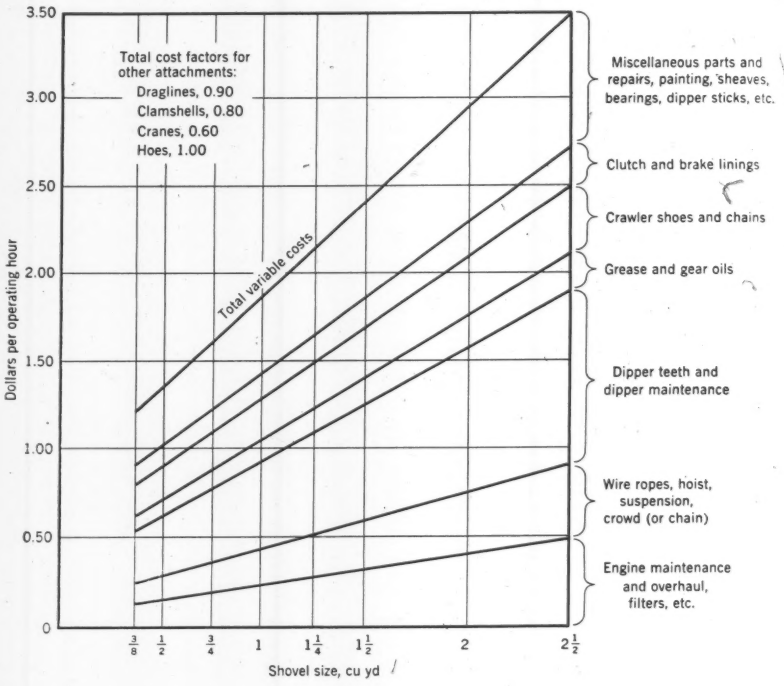

2.00
1.50
1.00
0.50
0
Dollars per operating hour
Gasoline engine fuel cost at 22¢ per gal
Diesel engine fuel cost at 14¢ per gal
Engine lube oil cost at 80¢ per gal
3/8 1/2 3/4 1 1 1/4 1 1/2 2 2 1/2
Excavator size, shovel rating in cu yd

FIG. 15. Variable machine operating costs (exclusive of engine oil and lubricating oil) include repairs, supplies, and general maintenance on power shovels. Factors for other attachments are given.



timated fuel consumption for both diesel and gasoline engines, and engine lubricating oil use. Figure 14 derives the hourly costs for fuel and lubricating oil under typical operating conditions based on average fuel prices.

Variable machine costs as estimated in Fig. 15 include repairs, supplies, and maintenance costs on power shovels. The estimated amounts for the various classes of repairs for the range of machines shown are not based on job records so much as on judgment as to what might be reasonable for shovel service. Modifying factors for other types of service are also given. Even though the individual items of the machine variable cost might differ considerably from the actual costs, the total cost probably is not too far from the average, but any machine may have costs departing from the average.

Labor and payroll expenses

In Fig. 16, the data contained in Figs. 12, 14 and 15, plus estimated hourly costs for the operator and supervision and employment costs, are combined to show a total hourly operating cost. Figure 16 graphically shows that the three major items of excavator operating costs are depreciation, interest on the investment, and labor cost, and these are probably the most accurately determinable items of cost. It can be seen that the amounts provided for repairs and supplies, which are most difficult to estimate, would affect the total comparatively little even if the estimated amounts differed substantially from the actual costs.

The operator's wage is a fairly constant item for all sizes, with only a slightly higher average for the larger machines. Oilers or operators' assistants are not so frequently used on the smaller machines, or their duties may be part time on the excavator. The amount in dollars for oilers' wages is thus shown as a smaller average for the small machines than for the larger ones.

The main feature of this chart is that it pictorially indicates the relative importance of each of the items making up the total operating cost. The user of the chart can modify the total if he feels any particular item is out of line on the basis of his own individual experience with excavators.

Yardage unit cost

The curves shown in Figs. 17, 18, and 19 are derived from the operating costs of Fig. 16, and the hourly excavator capacities from Tables I and II or Fig. 8 [in Part I, December 1954 issue].

The most notable thing about Fig. 17 is that in very easy digging the cost per cubic yard is not much more when using a small machine than a large one, and that in hard digging the large machine shows a more pronounced advantage. Even if the actual items of operating cost should vary considerably from those shown in Fig. 16, the relative position of the curves in Fig. 17 would not be materially changed, although the actual cost per cubic yard might be affected. For example, if the depreciation rate were cut in half, the cost per cubic yard in Fig. 17 would be reduced by about 10 or 15 percent, but the shape of the curves and their relative position would remain the same.

To prepare Fig. 18, one of the curves of Fig. 17 was modified for different operating efficiencies to show the effect of operating efficiency on the cost per cubic yard.

Besides operating efficiency, the cost per cubic yard is affected by the number of hours of average use per year during the depreciation period. A study of Fig. 19 will show that there would be a slight reduction in the unit cost if two-shift operation could be used instead of one-shift, but for three-shift operation there is very little further reduction. The difference in the unit cost for various hours per year is all due to the lower depreciation cost per hour for the larger number of hours per year, but there could be offsetting costs such as premium pay for second- and third-shift work and also reduced efficiency on the night shifts.

By showing the operating range of

FIG. 16. Total hourly operating cost includes both fixed and variable costs plus labor and supervision. Relative importance of various elements making up total operating cost is clearly seen.

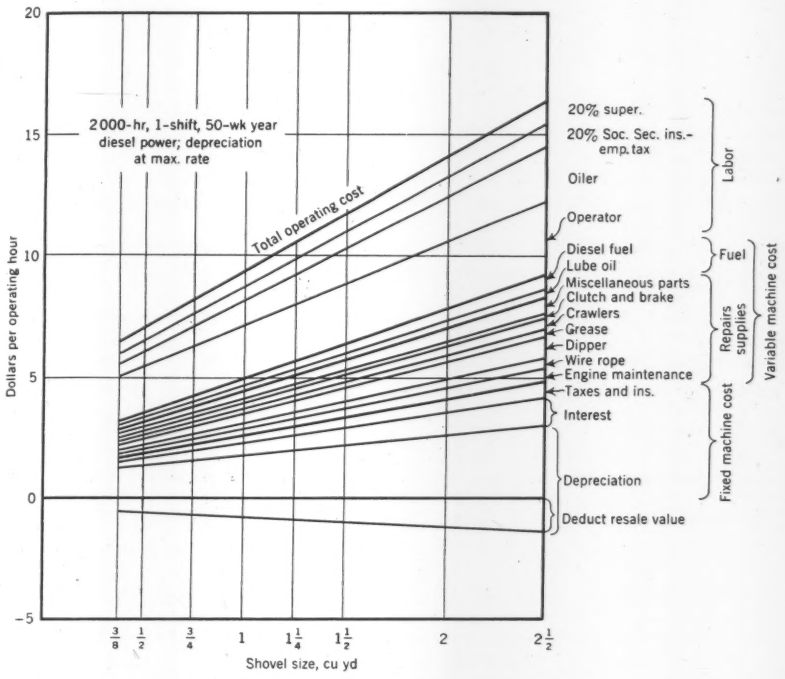
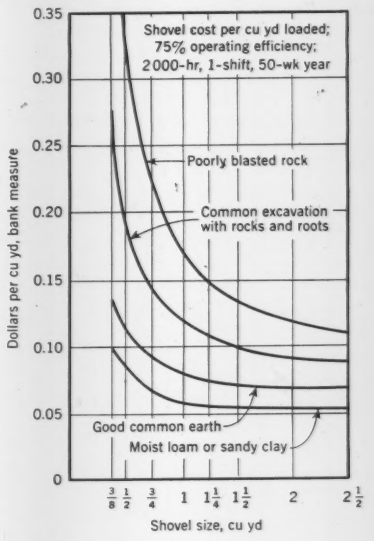


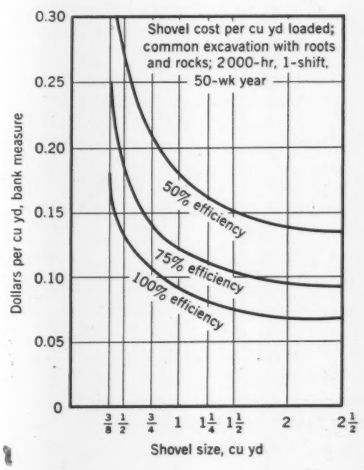
FIG. 17. Curves derived from Fig. 16 show effect of class of material excavated on cost per cubic yard, according to shovel size, at 75-percent operating efficiency. Note that in easy digging small machine costs little more than large one.


Shovel cost per cu yd loaded;
75% operating efficiency;
2000-hr, 1-shift, 50-wk year
Poorly blasted rock
Common excavation
with rocks and roots
Good common earth
Moist loam or sandy clay
Dollars per cu yd, bank measure
Shovel size, cu yd

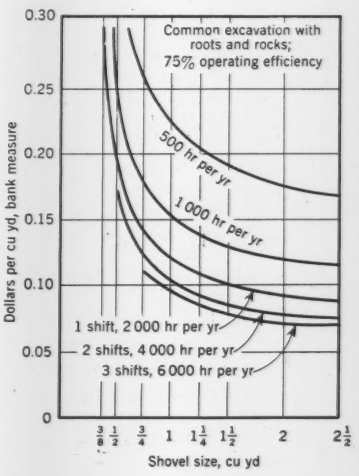
shovels, hoes, cranes, and draglines for all sizes of excavators in the commercial range on combination charts, a comparison between sizes is easily made. The lifting capacity and hourly digging capacities can also be plotted to give a clearer picture of relative capacities than can be had from tabulated data. The individual items of operating costs can be estimated and plotted to show the relative amounts and their importance as a part of the total operating cost of the machine. These cost items are averaged by plotting them as straight lines on the cost charts so that there is a uniform increase in cost for the larger sizes. This method of plotting the hourly operating cost for the various sizes of machines then makes it possible to plot the cost per cubic yard as a smooth curve for the several sizes, showing effect of working efficiency, class of material, and total time machine is used. In these charts the relative cost between sizes may be of as much importance as the estimated unit costs.

(This article is based on the paper presented by Mr. Martinson at the ASCE Annual Convention, before the Construction Division session devoted to "The Use of Construction Equipment—Choice, Capacities, Economy," presided over by Warren N. Riker and Walter L. Couse, Members ASCE.)

Right:
FIG. 18. Curve for common excavation with rocks and roots, from Fig. 17, is modified to show effect of operating efficiency on cost per cubic yard.



Far right:
FIG. 19. Effect of hours of machine use on cost per cubic yard is shown for one type of excavation, at 75-percent operating efficiency.


Common excavation with
roots and rocks;
75% operating efficiency
500 hr per yr
1 000 hr per yr
1 shift, 2 000 hr per yr
2 shifts, 4 000 hr per yr
3 shifts, 6 000 hr per yr
Dollars per cu yd, bank measure
Shovel size, cu yd

Flexible pavements developed for modern traffic

C. N. CONNER, M. ASCE, Principal Highway Engineer, U.S. Bureau of Public Roads, Washington, D. C.

New design criteria for flexible pavements are constantly evolving to meet the demands of modern high-speed, high-volume traffic. Experience, it is generally agreed, is the best teacher as regards pavement requirements. But with constantly changing traffic patterns, means must be found to integrate experience with laboratory and field tests if we are to achieve success in designing tomorrow's roads today.

Highway engineers are responsible for the design and construction of pavements and bridges. Both are commonly referred to as engineering structures, yet as such, they are vastly different. Unlike other structures, a highway pavement extends for great distances over the surface of the earth, traversing and supported by soils of a variety of types whose condition continually changes with time and climatic environment. On the other hand, a bridge or building emcompasses a relatively small area, involves fewer soil types, and is supported well below the earth's surface, where the condition of the material undergoes little change. Another significant distinction between the two types of structure is that pavement failures do not ordinarily endanger human life or cause as great an economic loss as would a bridge or building failure. For these reasons pavements are generally designed without a factor of safety, although such a factor is customarily employed in the design of other structures. This state of affairs has been responsible, over the years, for the design of many pavements which have proved inadequate under traffic.

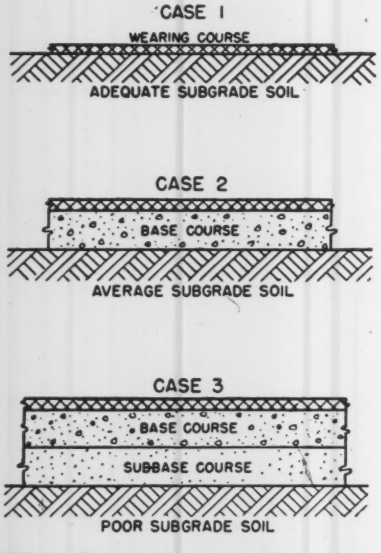


FIG. 1. Design of base and subbase solves problem of flexible pavements over varying soils. Required thickness of base and subbase must still be determined from designer's experience.

The fact that the development of methods for flexible pavement design has been an exceedingly difficult task is due to the many variable factors entering into the problem. Among these variables are: (1) character and condition of the subgrade soil; (2) wheel load, volume, and character of traffic; (3) changing climatic conditions; and (4) character of materials used in construction. The importance of the role played by all these factors in the design of flexible pavements is, however, now well recognized. As will be brought out later, the majority of our current methods of design take them into consideration.

At one time the design of flexible pavements was based largely on the experience and judgment of the engineer. This meant that as a general rule insufficient attention was paid to the character of the subgrade soil and to the quality of the materials used in the pavement itself. Had stage methods not been employed in building such pavements it is doubtful whether experience with this type of contruction would have justified a continuation of its use.

The initial move to consider the character of the subgrade soil in a serious way occurred in the early 1930's following the development of the Bureau of Public Roads' group system of soil classification. At about this time several of the state highway departments adopted the practice of arbitrarily varying the total thickness of the pavement in accordance with the character of the soil as determined by this system of classification. A few years later the idea of evaluating the soil by means of small-scale strength tests was advanced, and during World War II many airport pavements were built using a method of design revolving around the now well known California Bearing Ratio (CBR) test.

The manner in which the states are now handling the problem of flexible pavement design is shown by the results of a nation-wide survey completed in 1952 by the Committee on Flexible Pavement Design of the Highway Research Board. This survey was planned not to obtain complete details of the methods used but rather to compile information on the essential features of the methods. The results of the survey are presented in detail in Bulletin No. 80 (1953) of the Highway Research Board, entitled "Flexible-Pavement Design."

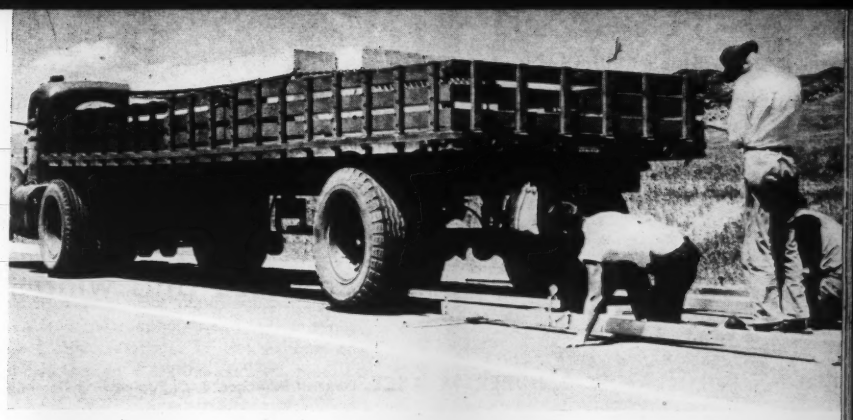
To get a realistic though limited view of the types of flexible pavements constructed since 1950, the plans, specifications and estimates of more than 400 projects in the 48 states were recently examined. From them some 40 projects were selected as reasonably typical of those constructed in 30 states.

Substantially all bituminous surfaces were from 20 to 24 ft in width, with a majority 24 ft wide. Surface types ranged from a surface treatment $^3/_4$ in. thick for light-traffic roads (300 vehicles per day), to hot-mix bituminous concrete 3 in. thick, or bituminous macadam $2^1/_2$ in. thick, for roads carrying fairly heavy traffic of 5,000 vehicles per day. Road mix was also used on various projects for intermediate traffic volumes.

Base courses were generally of untreated gravel or stone including water-bound and also traffic-bound macadam; some were of sand-clay or other local materials; and a few were of stabilized soil (Fig. 1). The untreated base thickness averaged from 4 to 15 in., with some of 18 and 19 in. where truck traffic was heavy and soil subgrade was poor; base courses were relatively thinner where admixtures of cement or bitumen were used to stabilize the materials. Subbases ranged in thickness from 6 to 18 in., and their use and thickness appeared to depend largely on subgrade soil type and volume of truck traffic. Although no mention was made of frost penetration, thicker sections are known to have been used up to a total of 30 in. where frosts are deep.

From maintenance reports on the projects studied, it was found that failures requiring repairs within the first 18 months of normal use were negligible. More recent reports were not available.

In general, available reports and data based on experience have indicated that the overall thickness of flexible pavements should vary from bituminous surface treatments on thin bases for very light traffic, to a total thickness of 22 in. and more on very poor subgrades for



Development of Benkelman Beam fills long-felt need for simple portable device for measuring pavement deflection under moving load.

large volumes of heavy truck traffic. There is not too much difference of opinion on this point since such variations are well established by actual practice in many localities. The real problem is the determination of rational design for conditions between these extremes, and that is why further research and its proper interpretation are necessary.

A practical approach combining tests with experience already is being made by at least two states, Kansas and Texas. In order to determine how strength tests of the subgrade can be converted into thickness of pavement, samples were taken of wearing surface, base course, subbase course and subgrade soil, tested in the laboratory, and the findings correlated with character and volume of traffic using such pavements. From the resulting data, these two states developed their present design methods.

Comparatively recent developments which should be watched with interest are:

1. Greater use of subbases on poor subgrade soils.
2. Stabilization of poor materials for bases or subbases by use of admixtures where good materials are not available.
3. One-course construction of relatively thick macadam bases by the combined use of vibrating equipment and rolling.
4. Use of crusher-run stone, slag, or other aggregate for the base course.
5. Use of bituminous penetration macadam or plant-mixed macadam for the base course, topped with hot-mix asphaltic concrete.
6. Improvements in mixing plants and pavers.

Present problems and their solution.

Because of the increase in weight and volume of truck traffic, the difficult and immediate problems are: (1) how best to improve inadequate pavements now in service, and (2) how best to design and construct proposed new pavements.

The need for some simple method of evaluating pavements in service has long been evident. This need appears to be met by an inexpensive, simple and portable devise recently developed and now in use for measuring the deflection of pavements under moving loads. The devise, known as the Benkelman Beam, was worked out by A. C. Benkelman of the Bureau of Public Roads in connection with the WASHO road test at Malad, Idaho. It measures deflection of the pavement surface caused by the wheels of a loaded truck or trailer as the vehicle moves forward at critical creep speed.

The beam can be put to very effective use by state and local highway departments in evaluating existing pavements, in establishing the seasonal load limitations so important in preserving investments in existing pavements, and in planning maintenance budgets and costs of reconstruction of existing pavements. The use of this beam now makes possible a direct approach for checking the validity of the design of pavements by actual measurements on the pavements as constructed.

This deflection measuring device consists essentially of a lightweight lever arm, the fulcrum of which is mounted on one end of a wooden datum beam. A leg extends downward from the free end of the lever arm, the foot of which contacts the pavement surface. The other end of the lever arm actuates a micrometer dial gage (an Ames dial was used in the WASHO test) which is attached to the datum beam. Typical tabulations of deflections obtained from actual tests on an existing pavement constructed to certain design standards on a subgrade of known classification are shown in Table I.

Studies on how best to design and construct new flexible pavements are being undertaken by a number of agencies. They include:

1. Cooperative investigation at Hybla Valley, Va., by Bureau of Public Roads, Asphalt Institute, and Highway Research Board
2. Road test at Malad, Idaho, by Western Association of State Highway Officials
3. Proposed AASHO road test in Illinois
4. Studies started by Civil Aeronautics Administration in connection with airports, at Indianapolis, Ind., and now being taken over by the U.S. Navy
5. Stress distribution research by U.S. Corps of Engineers at Vicksburg
6. Studies of pavements in service to check validity of method used in their design, notably in Texas and Kansas

The combined efforts of all these and other organizations should result in the development of improved and standardized procedures for designing flexible pavements to carry loads of known weights and volumes.

Progress is evidenced by general agreement on desirable types and thicknesses of bituminous wearing surfaces, as well as on suitable types and approximate thicknesses of base courses. The importance of subgrade support and the use of a subbase of appropriate thickness when subgrades are poor is being recognized.

The development of direct methods for evaluating the load-carrying capacity of existing pavements is well under way. Present and proposed field road tests on special test roads are showing, and will no doubt continue to show, important developments in flexible pavements as to the type, thickness, and width of sections needed for modern heavy traffic.

(This article is an abstract of Mr. Conner's address before a meeting of the Association of Highway Officials of the North Atlantic States in Washington, D. C., March 1954.)

TABLE I. Typical pavement deflection data obtained by Benkelman Beam tests, in inches

Total Thickness	Outside-Wheel-Pressure Deflection		Inside-Wheel-Pressure Deflection	
	Average	Range	Average	Range
13.	0.033	0.012–0.042	0.035	0.028–0.042
19.	0.037	0.024–0.056	0.034	0.014–0.052
25.	0.039	0.026–0.068	0.036	0.026–0.048
35.	0.044	0.018–0.077	0.039	0.026–0.048
38.	0.041	0.026–0.056	0.038	0.026–0.048
Grand Averages .	0.039	.....	0.036	.....

Kemano-Kitimat Transmission Line

Built to resist heavy ice and wind loads

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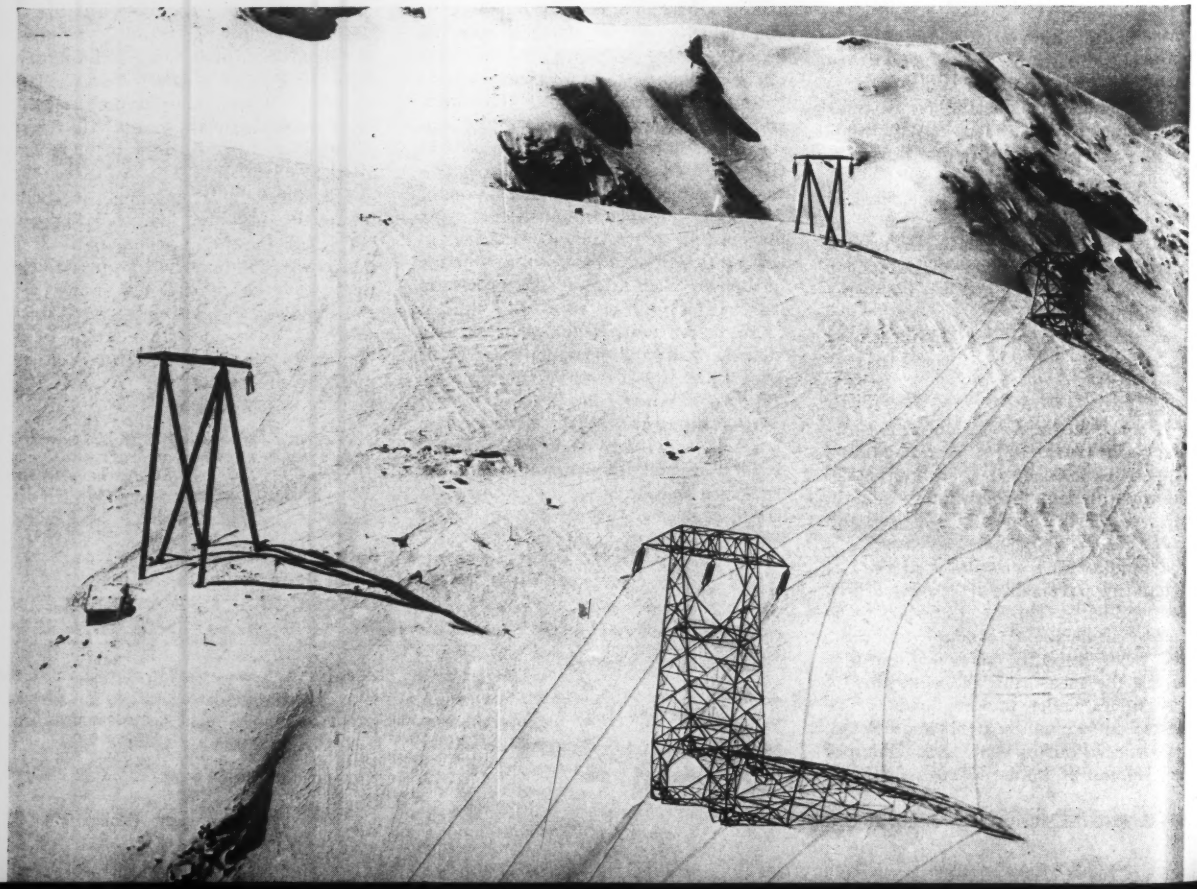
Line distance from the switchyard at the Kemano Powerplant to the load at Kitimat is 51 miles, and the rated transmission voltage is 287 kv. The approximate line location, which was established rather closely from Royal Canadian Air Force aerial photos used for the earlier project reports, was generally confirmed on the ground in one week of reconnaissance by helicopter during September 1949.

The pilot and engineer-observer, using caches of fuel and oil respectively at Kemano Bay and at the Indian village on Kitimat Arm, explored all promising valleys and passes between the powerhouse and the reduction plant sites as well as the all-shore route between the two. The intervening area was then only sketchily mapped, totally uninhabited and without roads, trails or other means of access, so that the success of the helicopter trip into these very rough coastal mountains was wholly dependent on the skill of the pilot and the reliability of his open-cockpit machine of about 200 hp.

The shore-line route, 30 miles to the west, following Gardner Canal and the east side of Kitimat Arm, is reasonably accessible from tidewater, and would afford a predominance of rock footings, but the distance would be about 85 miles, including several long water crossings and landslide slopes. The experience of the past three years, particularly as regards transportation costs, amply supports the decision against the shore-line route.

The selected valley and pass route, as shown in Fig. 1, actually runs quite direct and straight between termini.



View of completed transmission lines through Kildala Pass shows Camp 11, nearly buried in snow, between tops of towers in foreground. On ridge, at left of far aluminum tower, can be seen original experimental towers also almost covered with snow.

The aluminum smelter of the Aluminum Company of Canada, Ltd. (Alcan), at Kitimat on the coast of British Columbia about 500 miles northwest of Vancouver, is now operating on power produced by generating units by using about one quarter of the potential of 1,670,000 firm horsepower at the Company's Kemano Powerplant. Engineering and construction features were described in CIVIL ENGINEERING for November 1952 and February and June 1953. In this fourth and final year of the construction period, the exceptionally large and sturdy transmission system has been completed, checked over, and made ready to function under the severe winter conditions to be expected at the higher elevations along the route. No other feature of the power facilities has required more originality of planning, boldness of attack, or new, special, and outsize equipment and material. In this article, emphasis is placed on the civil engineering features of the line.

From the powerhouse near El. 200, the right-of-way follows the braided channel of the Kemano River for about nine miles to a future line switching station at El. 700, where the initial one double-circuit line is solidly connected to two single-circuit lines. This valley is so narrow that the gravel bars on both banks had to be utilized, since the mountain slopes are generally too steep and are often covered with slide rock. The river channels shift with every freshet and the consequent deposition of more gravel and sand from the upper reaches. The stream itself lacks any storage capacity and could reasonably vary twenty-fold in discharge within 48 hours.

The two single-circuit lines ascend a spur called Twin Peaks, through Glacier Creek Valley, over the rock fields of Kildala Pass at El. 5300, then descend along a hanging valley to the Kildala switching station at El. 500, a total distance of 9.5 miles. Increased cost of footings in Glacier Creek Valley to provide for greater snow depths and slide hazards was accepted as the alternative to a parallel ridge route of much more difficult access.

Down the Kildala River Valley and across the Dala River, site conditions were much like those in the Kemano Valley, except for the presence of silt and large quantities of ground water at tower sites. From the Dala, the double-circuit line runs up Green Mountain to El. 2900 and through considerable muskeg on granite, to tidewater again at Minette Bay, then across the Kitimat River delta at the head of Kitimat Arm to the aluminum reduction plant.

When construction on the project was started early in 1951, the available knowledge of meteorological conditions to which the transmission line would be subjected, was limited to two years of observations at Kildala Arm, one winter at El. 3000, and one winter of readings at an automatic line-load recording station at Kildala Pass. Even at sea level, temperatures reach −20 deg F, and at higher elevations winds are strong and snow accumulates to depths of 25 ft. Snow slides occur in rather well-defined areas. It appeared that construction seasons above El. 3000 could be only about four months long. Although the ice and rime loads measured by the test span were modest, the climactic conditions suggested heavy conductor loads similar to those experienced in the high Alps, and on transmission lines in Washington and Oregon, where a combination of temperature, humidity, and wind have produced heavy icing about every seventh year.

The Kemano-Kitimat transmission system is simple because the aluminum plant takes practically all the transmitted energy at a load factor of nearly 100 percent, but this system must be extremely reliable since an outage of more than a few hours would result in damage to the pots and some loss of production. Even under ideal conditions it would be almost impossible to repair a line in so short a time; therefore two circuits have been provided initially throughout. The ultimate transmission load will be 300,000 kw on each of the four circuits of the two double-circuit lines, and 600,000 kw on each of the single-circuit lines. In sections of line along the valleys, where ice and wind loads will probably be less severe and access for maintenance less difficult, the lighter double-circuit construction was adopted for its better electrical characteristics.

Electrical storms are very infrequent in the region; therefore ground wires are installed for only about one mile at each end. Towers on concrete piers are individually grounded, but no counterpoise is used. Phase transpositions are

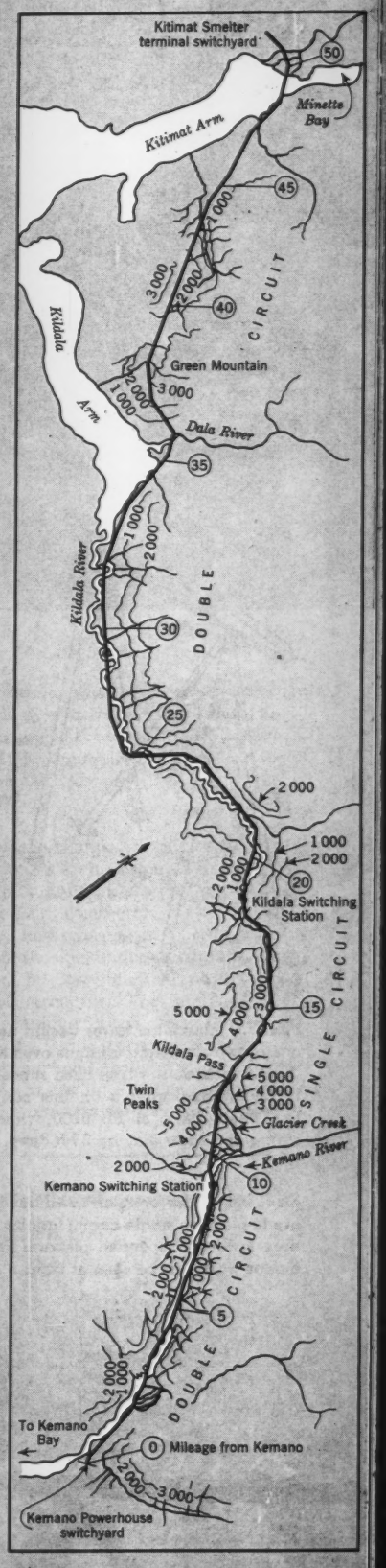
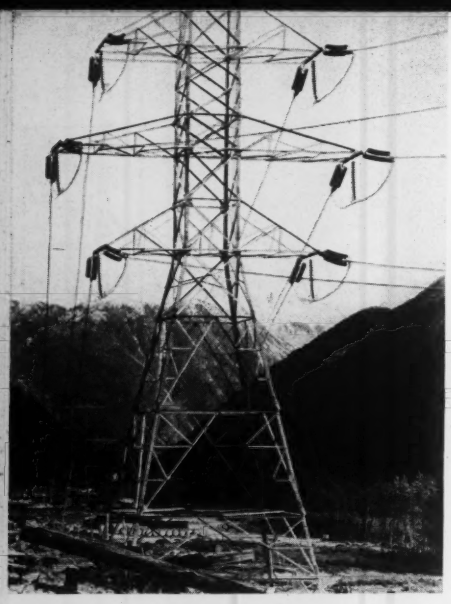


FIG. 1. Transmission line 51 miles long connects hydroelectric plant at Kemano with aluminum reduction plant at Kitimat, British Columbia. Most of length consists of double-circuit line, but for 9.5 miles over Kildala Pass there are two single-circuit lines, one on steel towers, one on aluminum towers.



Initial transmission line for Alcan–British Columbia Projects consists of two circuits. In more protected valley sections, the two circuits are carried on a single steel tower, designated as the "double-circuit line," here seen running through Kemano Valley. Heavy-angle tower in foreground stands 117 ft high, has long arm 56 ft from end to end, and base dimensions of 37 × 37 ft. Double-circuit towers average 20 tons of steel each.

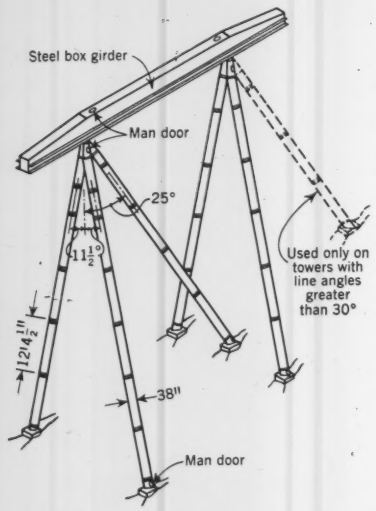
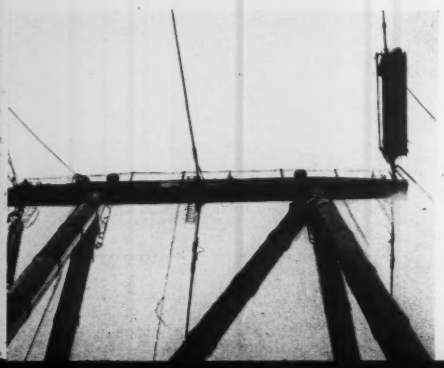


FIG. 2. Aluminum tower design used for one of two single-circuit lines over Kildala Pass is extension of type used successfully in Swiss Alps, unique on this continent. In Kildala Pass, at El. 5300, winds are strong and snow may be 25 ft deep.

Steel box-girder cross-arm and conductors are in place on single-circuit tubular aluminum tower. Suspended platform for conductor work can be seen at right.



made at the Kemano line switching station and at the Kitimat terminal.

While the first survey parties, supplied by helicopter and air drops, were laying out the preliminary location lines in heavy timber and over precipitous rock surfaces above the timber line, conductor loadings were being established at levels about twice as high as those of any other known line, and the steel tower design got under way in September 1951. The decision to build both single-circuit lines initially, thus avoiding reconstruction of access and camps in the high areas at a later date, led to design of the aluminum towers in 1952–1953. The loads specified for conductors and towers are given in Table I.

Framing and general design of the two types of steel towers are indicated in the photographs, and the geometry of a typical aluminum tower is given in Fig. 2. The following snow-creep pressures were assumed for the design of tower legs where substantial snow depths are expected:

Heavy snow action:

For all tower members from ground line to a height of 19 ft:

1. Load of $(3{,}000 - 100h)$ lb per lin ft of horizontal projection of member length, where h is height in feet above ground line
2. Load of 300 lb per lin ft of vertical projection of member length

Light snow action:

For all tower members from ground line to a height of 13 ft:

1. Load of $(1{,}000 - 40h)$ lb per lin ft of horizontal projection of member length, where h is height in feet above ground line
2. Load of 100 lb per lin ft of vertical projection of member length

Towers to withstand these extremely heavy loads and to support conductors at a minimum height of 35 ft above bare gound in the valleys and 25 ft along the single-circuit sections, required exceptional weights of metal, despite the use of silicon steel for the large leg angles. The total weight of steel in the 231 double-circuit towers, including grillages, is 4,523 tons, or an average of 39,000 lb per tower. The total for the 42 single-circuit steel towers is 1,725 tons, an average of 82,000 lb per tower.

The aluminum towers of the 9.5-mile Kildala Pass section are an extension of a design which has a record of service in Switzerland. The left, or southerly, single circuit over Kildala Pass is carried on 35 towers made up of five or six tubular legs of 38-in. diameter and a box-girder cross arm. Leg bases and the A-frame and tripod heads are galvanized weldments of plate steel. Towers were designed for the topography and snow conditions at each specific site, the wall thickness of the legs varying from $^3/_{16}$ to $^3/_8$ in.

Tower leg sections are joined by high tensile bolts and jaw clamps on internal flanges to minimize eccentricity and simplify assembly. Man doors in all bases and aluminum ladders in each leg provide permanent safe access throughout the towers, and to the top of the cross arm by opening out a platform hinge-connected to the head. Cross-arm reactions are carried to the heads through a ball-and-socket seat with bolts to limit uplift.

One each of the three types of towers (single-circuit steel, double-circuit steel, and single-circuit aluminum) was tested under maximum loadings to check the design and fabrication.

Tower footings resist scour and uplift

Tower footings and anchorages vary everywhere along the line to suit foundation conditions. Grillage anchors for the double-circuit towers in unconsolidated materials are tripods embedded in a concrete slab large enough to pick up the required mass of backfill. Where there is danger of stream scour, angle stubs are cast in concrete piers of sufficient size to carry all leg reactions unaided by backfill. Where ledge rock is available, stubs are concreted into holes, or bolts are set to take a shoe to which the tower leg is bolted. This latter type provided desirable flexibility for adjustment when a tower was being erected, whereas it was necessary to hold stub settings very close to exact locations. Concrete-capped pile footings proved best in some of the wet and softer ground and are used exclusively across the tidal flats at Kitimat.

Single-circuit tower anchorages are of several types. Some consist of 2 and $2^1/_4$-in. silicon steel bolts grouted into 4-in. holes drilled about 10 ft deep in sound rock; others have the bolts embedded in concrete in an excavated hole from which dowels extend downward and radially to secure additional rock; in still others the bolts are set in individual piers in talus. In Glacier Creek Valley the anchorages consist of floating box bases of reinforced concrete on earth. The steel shoes of both alumi-

To keep conductors of 2.3-in. diameter clear of rough ground, 12-ton skid-mounted tensioning machines were used. To string lighter lines of 1.5-in. diameter, winches and tractors proved adequate.

Compressor, suspended on construction high line, is on its way down to Camp 10 for repair. Access road and Kildala Pass appear at upper left. Steep "cat road" branch leads to camp.

num and steel single-circuit towers were readily adjusted and held in position by the anchor bolts. High-strength expanding grout was used for setting bolts in the drilled holes. Footings for the 231 double-circuit towers contain 14,000 cu yd of concrete, and footings for the 77 single-circuit towers contain 6,600 cu yd.

Conductors and fittings of large size

The largest standard A.C.S.R. (aluminum conductor, steel reinforced) conductor, designated "Falcon," is used for the double-circuit sections of the line, but a much larger special section, named "Emu," had to be manufactured for the single-circuit run. The characteristics of these conductors are listed in Table II.

Except for jumpers at strain towers, all insulators are standard 10 in. × 5¾ in. clevis type, 25,000-lb units, in single or multiple strings up to six, as follows:

Double circuit:		
Suspension	1 or 2 strings	16 units
Strain	3 strings	18 units
Single circuit:		
Suspension	3 or 4 strings	18 units
Strain	6 strings	20 units

The yokes, spreaders, and linkages required to make up these insulator assemblies had to be developed and tested especially for use with the Emu conductor. Proof tests of the clamps gave average values of 30,000 and 75,000 lb under vertical loads, and 10,000 and 30,000-lb slip-strength for the Falcon and Emu sizes respectively. Clamp curvature provides for a maximum deflection of 34 deg from the horizontal axis of the clamp. Sixteen applications of 130 tons each were used in compressing the aluminum sleeves at the joints in the Emu conductor.

Sags and tensions are based on a conductor tension under maximum design load of 50 percent of the ultimate conductor strength. The standard A.C.S.R. graphic method of sag tension calculations, with correction factors for steeply inclined spans, was used for the double-circuit lines. The design of the single-circuit profile however followed a

TABLE I. Loads specified for conductors and towers

Single circuit:

A. Ice load of 40 lb per ft of length at 0 deg F, to produce yield-point stresses in the tower members

B. Radial ice 2½ in. thick at 57 lb per cu ft, to produce design stresses in tower members

C. Radial rime 2 in. thick at 19 lb per cu ft, combined with wind at 8 lb per sq ft of conductor projection, to produce design stresses in tower members

D. Radial rime ¾ in. thick at 19 lb per cu ft, combined with wind at 11 lb per sq ft of conductor projection, to produce design stresses in tower members

Double circuit:

A. Ice load of 24 lb per ft of length at 0 deg F, to produce yield-point stresses in tower members

B. Radial ice 2 in. thick at 57 lb per cu ft, to produce design stresses in tower members

C. Same as loads given in "*C*" for single circuit

D. Same as loads given in "*D*" for single circuit

TABLE II. Characteristics of conductors for transmission line

	Double Circuit	Single Circuit
A.C.S.R. (aluminum conductor, steel reinforced) code word	"Falcon"	"Emu"
Size, circular mils	1,590,000	3,364,000
Stranding: Aluminum	54 × 0.1716 in.	108 × 0.1765 in.
Steel	19 × 0.1030 in.	37 × 0.1261 in.
Diameter of steel core, inches	0.5150	0.8827
Diameter of complete cable, inches	1.5450	2.2947
Weight, lb per ft	2.032	4.760
Ultimate strength, lb.	55,400	135,400

special and perhaps unique sag tension method, which takes into consideration the effect of the widely varying spans in a series, the steep slopes, and the variations in maximum design tensions in adjacent series of spans. Here the final design conductor-tension could go to a maximum of 68,000 lb. To compensate for the tendency of the conductors to oversag downhill, clamps were offset from the vertical by a distance calculated to equalize horizontal tensions and leave suspension insulator assemblies hanging vertical. Early experience showed that multiple-string strain assemblies will naturally rotate to bring the long axis of the cross section generally parallel to the ground.

Access to the site of the transmission line, as for most other features of the whole development, required exceptional effort and departed further from orthodox techniques than the remainder of the construction work. Material yards were established at Kemano Bay, 11 road miles from Mile 0; at Kildala Arm, Mile 33; and at Minette Bay, Mile 48. Barge loads were hauled about 500 miles from Vancouver to each of these yards for distribution by truck to points along the line.

Although the southerly two miles of single circuit was built almost entirely from high lines, a road was pushed over Kildala Pass to effect junction, in the fall of 1952, with the road from the north. From this primary road, tower sites were supplied over branch cat roads or by cableway as appeared feasible. Grades are steep and surfacing material scarce on the high ground, which resulted in high costs for road maintenance. Pioneer hauls were by tractor and Athey wagons, but most of the tonnage was carried on 6 × 6 trucks and four-wheel-drive trucks, some of special design.

A fleet of Bell helicopters proved invaluable for the transport of personnel and light freight throughout the job. Two Sikorsky S-55 helicopters were used for heavier freight up to 1,500-lb loads, particularly on camp construction ahead of the road.

Line construction required eleven major camps, of which eight were tent camps, and three of frame construction, plus several smaller fly camps on Twin Peaks. Camp No. 10 in Glacier Creek Valley was buried under 25 ft of snow each winter, and Camp No. 11 at the pass had to be metal sheathed on anchored heavy timber to withstand strong winds and deep snows. Since it was necessary to open these camps while the snow was still deep, and keep them open until December for two seasons, the cost of camp operation outran all estimates.

Supply of aggregate for footing concrete is another item which called for much resourcefulness on the part of the job management. Although sand and gravel were available along the rivers, it was economical to install recovery and processing plants at only a few points, from which the aggregate had to be hauled to the tower sites. Thus concrete was transported in Dumpcrete trucks from the Powerhouse plant, or from one of three concrete plants between Miles 30 and 48. When these hauls became too long, batched aggregate was bagged and trucked to sites for mixing in a small machine, except for the large framed footings on talus in Glacier Creek Valley, where a crusher and sand plant was used to process local rock.

The first group of grillage footings were set from templets, but later in the job the preferred method was instrument location of each grillage. Experience proved that tolerances allowed in setting stubs also established the practical limit with respect to tower erection.

Too much subassembly of tower steel and tightening of bolts also added difficulties in tower erection. Considerable falsework was required at most sites for assembling the three parts of the aluminum tower cross-arm, but the gooseneck erection jibs proved efficient for hoisting and positioning the complete cross-arms on top of the A-frame heads. At accessible sites, truck cranes with extra-long booms were used for tower erection, the top members being set with aluminum floating gin poles. Elsewhere towers were erected member by member, entirely with gin poles.

Legs of the aluminum towers were built up as cantilevers from the base, using a special aluminum boom off the end of the assembled portion for hoisting up each successive "can" 12 ft 4½ in. long. Complete legs were then guyed for hoisting and positioning A-frame and tripod heads.

All six conductors of the double-circuit line were strung simultaneously by the conventional winch and tractor method, but several 12-ton skid-mounted tensioning machines were used when running out the larger single-circuit conductor to keep it clear of the rough ground surface. Conductor lengths were limited by reel size and weight to a maximum of about 2,200 ft. Sag was adjusted by sighting from control spans with a transit and by radio signaling for winch operation. Fog often cut off all communication between stations. Perhaps the most significant figure obtained from the construction record was that the average single-circuit steel tower required twice as many man-hours as the average double-circuit tower.

Experience to date has led to the strengthening of some steel lateral bracing which had bent under snow loads, and the installation of vibration dampeners in the legs of the aluminum towers. Devices have been attached to the legs of both types of single-circuit towers to measure snow creep pressures, and the permanent line-shelter building on the pass will be manned for several seasons to obtain additional data on operating conditions. One Sikorsky and two Bell helicopters, with pilot and mechanic, will be kept at Kitimat for line inspection and maintenance. The second pot line at the smelting plant was put on the line in September 1954.

Principal representatives of the owner are P. E. Radley, Manager; F. T. Matthias, M. ASCE, and J. S. Kendrick, A.M. ASCE, Assistant Managers, Alcan B.C. Project; and K. Roestad, Resident Engineer. Design of the aluminum towers was by Aluminum Laboratories Ltd., an affiliate of Alcan, and the remainder of the transmission-line engineering was by British Columbia International Engineering Co. Ltd., C. P. Dunn, M.ASCE, President. The writer was General Manager of this firm until Oct. 1, 1954. Construction was by the Morrison-Knudsen Co. of Canada, Ltd., A. O. Strandberg, Project Manager.

Helicopters proved invaluable for route surveys and for transporting construction personnel, materials, and light equipment. Here a Sikorsky S55 carefully "drops" 18 cases of dynamite on Kildala Pass.

Is engineering being taught backward?

JOHN B. WILBUR, M. ASCE

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This thought-provoking article is published at the request of the ASCE Task Committee on Engineering Education (formerly called the Task Committee on Engineering) Curricula, and on recommendation of the ASCE Committee on Engineering Education.

The importance of science in the education of the professional engineer is widely accepted and scarcely needs stressing. We should, however, be on the alert to see that as the scientific content of our engineering curricula is strengthened, we maintain and if possible strengthen that part of the program which develops judgment, perspective, imagination, and creative ability as applied to total situations. The difficulty is two-fold. Not only does increased scientific content displace subjects of a more comprehensive nature, but rigorous training in the exactitudes of science, mathematics, mechanics and the like—in which little is left to judgment—may actually make it more difficult for the student to exercise judgment and imagination on matters of broader scope where intangibles as well as tangibles are present to an important degree.

In the face of this dilemma, we believe that serious consideration should be given to a partial inversion in the manner in which undergraduate engineering is now taught. Instead of saying that since engineering is applied science, science must be taught before its application to engineering problems, it might be more effective to teach total concepts of the art of engineering before the more detailed scientific aspects of the technology.

This would tend to make the student think in the larger spheres of function, economics, and social impact as his basic approach to engineering. He would begin by considering comprehensive problems, which he would work out as best he could without the full benefit of science. And he would soon discover for himself that science is needed to achieve better solutions to engineering problems.

With the student thus motivated, it should be possible to teach science more effectively than would otherwise be possible; and of equal importance, science would be approached in the proper perspective—as an extremely important tool of engineering, but not as engineering itself.

It seems possible, moreover, that this approach would strengthen our programs in the humanistic-social areas, since a comprehensive treatment of many of our civil engineering problems could not be properly undertaken without considering the social, political, and economic aspects of the situation—thus pointing up the fact that many of the studies now classified as part of the humanities program are not a thing apart from civil engineering but indeed part and parcel of the total problem.

Perhaps it is not too much to hope that this suggested approach to undergraduate engineering education might lead not only to better engineers but to citizens of broader interests, who would be more interested in—and better fitted for—eventually filling positions of leadership in the administration of industrial and government affairs.

More training for young civil engineers

HARRY A. WILLIAMS, M. ASCE

Member, ASCE Committee on Engineering Education

Professor of Civil Engineering, Stanford University, Stanford, Calif.

The following timely article was recommended for publication by the ASCE Committee on Engineering Education and is the first of a series from this source.

If any civil engineer were asked whether he is interested in the education and training of young engineers, his reply would be an emphatic "yes." If the next question were, "What are you personally doing to improve their training?" many of us would have difficulty in answering.

The Society's Committee on Engineering Education has been concerned with this problem. It recognizes that more emphasis is being placed on the basic courses in the undergraduate college curriculum with the result that less time can be given to the applied courses. Hence there is an increasing need for training after graduation.

Every employer realizes that he must give a young engineer some training. In most cases, it requires months to do this. Many industrial organizations recognize the benefits to the company and to the individual of a training program for young men entering their organizations. Although some companies that hire civil engineers primarily also recognize the advantages of such programs, it is questionable whether they do as much in this respect as do employers of graduates in the other branches of engineering.

It has been traditional to expect the civil engineering college graduate to earn his initial keep at such skills as surveying and drafting. Since these subjects have been relegated to a position of lesser importance in modern college curricula, the young man usually needs considerable help when he enters these

(*Continued on page 94*)

Precast slabs form air-intake plenum

Precast concrete slabs of the type widely used in industrial roof decks for more than half a century have found a new use in Chicago's huge 2,359-car Grant Park underground garage, recently completed. Such slabs make up the 131,000-sq ft suspended ceiling which encloses a 450,000-cu ft plenum chamber for the garage ventilating system.

The precast reinforced concrete slabs, approximately 2 × 5 ft, rest on T-irons bolted to steel hangers suspended from the poured concrete roof on the upper level of the two-story garage (Fig. 1). This arrangement not only simplified the ceiling construction, but provided a permanent, maintenance-free, non-combustible surface.

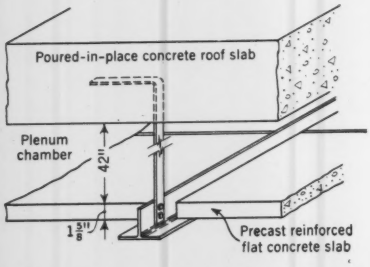


FIG. 1. Plenum chamber for garage air intake is formed by precast concrete slabs resting on T-irons, which in turn are bolted to steel hangers cast in poured concrete roof. Slabs are about 2 × 5 ft, and $1^5/_8$ in. thick.

After being lifted from trucks to the T-irons, the slabs were sealed at all joints on the upper side with an asphalt asbestos mastic. The entire under surface of the slabs and the toes of the T-irons were then painted white, presenting the appearance of a flush ceiling surface into which glass-enclosed fluorescent lighting units were recessed.

The slabs, $1^5/_8$ in. thick, are designed for an ultimate load of 250 psf, and are reinforced with No. 10 galvanized wire mesh. A total of 13,298 slabs was required for the project. Of these, 70 percent are a standard size, $23^7/_8$ in. × 4 ft 9 in. Provision for recessing the flush fluorescent lighting fixtures was made by the slab manufacturer, who cast special slabs with a rectangular cutaway.

Fresh air is drawn into the plenum chamber through intake louvers installed under the seats and terrace walls in Grant Park—which is being restored to its original appearance on top of the garage roof. The air is drawn into the garage from this chamber and then exhausted through grills on the west wall by means of 28 tube axial fans ranging from 20 to 30 hp. These fans handle 1,766,400 cu ft of air per min, to provide 15 complete air changes per hour.

The Grant Park garage, which extends three blocks under Michigan Avenue and under a substantial section of the west part of the park, is owned and operated by the Chicago Park District. Ralph H. Burke, Inc., and the John Griffiths & Son Construction Co., both of Chicago, were the designers and general contractors, respectively.

Precast slabs normally used for roof decks find new function as suspended ceiling in Chicago's 2,359-car garage under Grant Park and Michigan Avenue. Top story of two-floor garage is seen in both views. View above shows steel hangers suspended from poured concrete roof, with some T-irons already bolted to hangers. Slabs rest on T-irons. Through plenum chamber thus formed, fans draw fresh air into garage to provide complete change of air every four minutes. Some slabs were specially manufactured with rectangular cutout for recessed fluorescent lighting units, seen in completed view at left.

Can design be based on ultimate strength?

ROBERT L. KETTER, J. M. ASCE, Research Instructor
BRUNO THURLIMANN, Research Assistant Professor

Fritz Engineering Laboratory, Department of Civil Engineering and Mechanics, Lehigh University, Bethlehem, Pa.

During the past 25 years much research has been carried out both in Europe and this country on the problem of the ultimate load-carrying capacity of steel structures. While numerous research reports have been published, few applications of these findings have been made in design. Actually, the assumptions of such an analysis and the mechanics involved in such a design procedure are relatively simple.

Before going into these, however, consider present-day structural specifications. Generally, these prescribe allowable stress values which theoretically, if multiplied by the factor of safety, would correspond to first yield of the most stressed fiber. Such an analysis does not give any indication of the reserve in strength the structure may possess beyond this stress condition. In several instances, however, this yield concept has been abandoned. For example, riveted connections are designed for average strength and not for the load producing first yield on the most stressed part. Also, section 15(*a*)(3) of the AISC Specification allows a 20 percent increase of stress caused by negative moments over the intermediate supports of a continuous beam. This provision recognizes that the possibility of yielding at such intermediate points is not detrimental to the overall load-carrying capacity of the structure.

In contrast to conventional elastic design, plastic design does not make use of allowable stresses, but is based on the ultimate load-carrying capacity of the structure. For design by this method then, one would first multiply the given loads by a load factor of safety and then proceed to determine the sizes of members which would at their ultimate strength be able to support these stepped-up loads. That this ultimate strength analysis requires parts of the structure to yield is of relatively minor concern since mild steel is by its very nature quite ductile and can undergo large plastic deformations. It should be noted, however, that under normal working loads yielding will seldom, if ever, occur.

To understand the mechanics of this type of "plastic" analysis, it is necessary first to understand the actual behavior of structural members strained beyond the elastic limit. For illustration consider the bending behavior of the typical wide-flange, mild-steel section shown in Fig 1. Starting from a zero moment, there is a linear region known as the elastic range wherein an increase in moment corresponds to a linear increase in curvature, ϕ. Above the initial yield moment, M_y (that moment corresponding to yield of the most extreme fibers), this condition no longer holds and curvature increases at an ever increasing rate, leveling off at a value known as the plastic moment, M_p. For rolled wide-flange shapes bent about their strong axis, M_p is on an average about 14 percent greater than M_y. For weak axis bending, it is about 50 percent greater.

In simple plastic theory, it is assumed that a moment approaching this plastic moment, M_p, produces an indefinite amount of rotation in the member. One investigator has compared this action to that of a "rusty hinge," which requires a certain moment value to initiate rotation. In general the term "plastic hinge" is used to define this phenomenon.

The influence of axial thrust on this bending deformation behavior is to cause the section to yield at an earlier moment and consequently reach a plastic-hinge condition sooner. The moment value corresponding to such a hinge is usually referred to as a modified plastic-hinge moment (modified in that axial thrust has caused a reduction in bending moment capacity over that of pure moment). Figure 2 is a plot showing the variation in the modified M_p values for a typical wide-flange shape bent about its strong axis. As can be seen from this figure, if P is relatively small (say below 15 percent of the yield load under pure axial thrust) its influence on the plastic moment can be neglected.

Having this basic bending information in mind, consider now the behavior of the simple beam shown in Fig. 3(*a*). As Q increases, the moment at the center section of the beam also increases, as shown in Fig. 3(*b*). Since the latter must follow the moment curvature plot of Fig 1, loads can be applied up to a value of Q_y (that load corresponding to M_y at the center section of the beam) with a corresponding linear increase in deformation. Further increase in load is accompanied by a greater rate of increase in deflection. Finally, M_p is reached at the center of the beam, a plastic hinge is formed, and the ultimate load, Q_p, is obtained.

If it is assumed that the allowable bending stress is 20,000 psi, and the yield stress is 33,000 psi, Q_y will be 1.65 times greater than $Q_{allowable}$, the allowable design load. Further, since M_p is approximately 14 percent greater than M_y for bending of a wide-flange section about its strong axis, Q_p will be approximately 14 percent greater than Q_y. The true load factor of safety of the simple beam then is

$$(1.65)\ (1.14) = 1.88$$

The behavior of a statically indeterminate structure differs from that of the simple beam discussed above. Consider for illustration the two-span continuous beam with loading as shown in Figure 4(*a*). As the loads, Q, increase, M_p is first reached at Sections B and D, the moment diagram being similar to that shown in Fig. 4(*b*). The attainment of these M_p values, however, does not mark the ultimate carrying capacity of the beam, since the loading can now be considered as shown in Fig. 4(*c*).

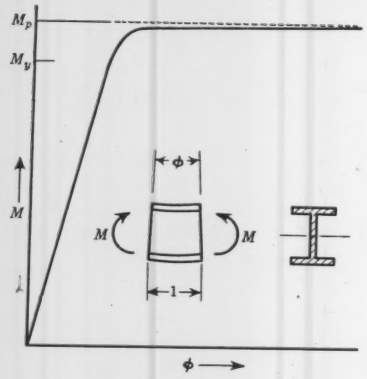


FIG. 1. Bending behavior of typical wide-flange mild-steel section is shown by curve of bending moment versus curvature.

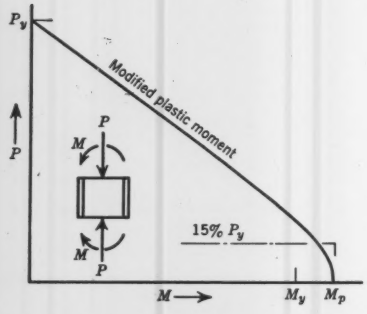


FIG. 2. Variation in modified M_p values, as influenced by axial thrust, is plotted for typical wide-flange shape bent about its strong axis.

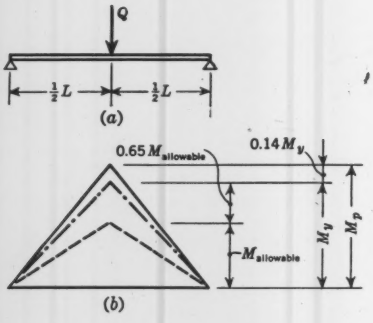


Fig. 3. Bending moment diagrams for simple beam loaded as shown in (*a*) are given in (*b*) for allowable, initial yield and ultimate loads.

A further increase in Q will cause a redistribution of bending moments, and a plastic hinge will finally form at Section C as shown in Fig. 4(*d*). At this stage a mechanism is formed (that is to say, the structure will deform appreciably with only the slighest further increase in load) and the maximum loading is reached.

This step-by-step procedure is actually not required in a typical design problem. On examination of the loading it is realized that maximum moments occur at each of the load points and at the center support. With this, Fig. 4(*d*) can be drawn immediately.

For design purposes then consider the moment diagram of ultimate load as shown in Fig. 4(*d*). It is evident that the left reaction at point A can be given by either of the equations

$$R_A = M_p/a$$

(Taking moments about B and considering that part of the beam to the left of Section B)

or

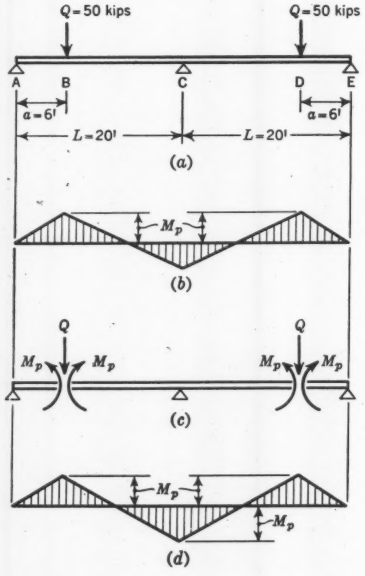
$$R_A = Q(1 - a/L) - M_p/L$$

(Taking moments about C and considering that part of the beam to the left of Section C)

Equating these expressions gives

$$M_p = Q\,a\left(\frac{L-a}{L+a}\right)$$

Assuming the same load factor of safety as for the simple beam (that is, 1.88), the required section modulus



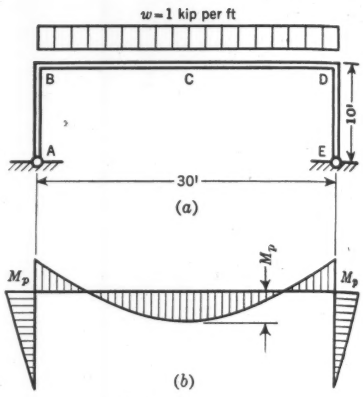


FIG. 5. Portal frame with rigid connections at beam-column junctions is shown in (*a*), and its ultimate load moment diagram in (*b*).

would approximately be given by the expression

$$1.88\,Q\,a\left[\frac{L-a}{L+a}\right] = M_p = 1.14\,M_y = (1.14)\,(S)\,(\sigma_y)$$

where

S = section modulus in direction of bending

σ_y = yield stress (for ordinary structural steel, minimum σ_y = 33,000 psi)

or (Required) $S =$

$$\frac{(1.88)\,(50)\,(72)\,(168)}{(1.14)\,(33)\,(312)} = 97.1 \text{ in.}^3$$

Choosing the lightest rolled wide-flange shape, this would call for a 18WF55 having a total weight of main member of 2200 lb. Design according to the AISC Specification (here again choosing the lightest member) would require an 18WF60 with a total weight of 2,400 lb.

The maximum bending stress produced in a continuous 18WF55 beam by the 50-kip design loads would not exceed 20,700 psi. The ultimate load capacity of this beam would be as great as that of two 20-ft simple-span beams having a bending stress no greater than 20,000 psi at design load. If headroom limitations were such that a greater

FIG. 4. Statically indeterminate structure is represented by two-span continuous beam, loaded as shown in (*a*). Plastic moments start to develop at B and D as indicated in (*b*), and a further increase in load (to its ultimate value) will result in the moment diagram given in (*d*).

beam depth could not be used, these simple-span beams would have to be 18WF70. Otherwise 21WF62 would suffice. Using either of these shapes, the maximum simple-span deflection at design load would be greater than that using the 18WF55 continuous beam. For the 18WF70 it would be 40 percent greater.

This same "plastic design" reasoning can be extended to the design of a portal frame having rigid connections at the beam-column junctions (see Fig. 5). In this case plastic hinges form at Sections B, C and D. Noting that this arrangement and number of hinges is sufficient to produce a mechanism, the ultimate load moment diagram can be drawn as shown in Fig. 5(*b*). Since the sum of the moments at Sections B and C, and at C and D, must total the simple beam bending moment,

$$2M_p = 1/8\ wL^2$$

or

$$M_p = 1/16\ wL^2$$

Here again applying a 1.88 load factor of safety, one possible design would be a 12WF27 section for both beam and columns. A check of the relative amount of axial load present on the column indicates that the axial thrust does not materially reduce the plastic moment of the column and can be disregarded.

That frames of this type can be depended on to carry such loads and behave as predicted has been demonstrated by full-scale tests of portal frames loaded to collapse at Lehigh University. Results of these tests are reported in various publications of the *Welding Journal* and the *Proceedings* of the Society for Experimental Stress Analysis.

In considering a new type of design criterion, the designer certainly is justified in asking what advantages the proposed method offers over the established one. It must be admitted that present-day practice, which considers "first yield" as the design criterion, leads to a safe structure. But what does it tell about the actual safety of the structure? Plastic design offers the following advantages:

1. Design is based on the actual ultimate strength of the structure and not on some arbitrary limit short of this target.

2. The methods of analysis are simpler. The example of the portal frame illustrates this point in particular.

3. For redundant structures, economy of design will result since redistribution of bending moments will require that more parts of the structure develop their maximum bending strength.

THE READERS WRITE

For safety's sake— a needed change in automobile design

TO THE EDITOR: One important factor in automobile design has been mistakenly evaluated by the public and by automobile designers alike, with the result that many of the most recent models are less safe than the designs they are supposed to be an improvement upon. This factor is the height of the vehicle—overall height, and more particularly the height of the driver's line of sight.

The most obvious advantage of height is illustrated by cars approaching each other over a hilltop. The higher the driver's line of sight and the higher the approaching vehicle, the sooner the driver will see it. For example, the drivers of two model-T Fords, approaching over a vertical curve with a radius of 2,000 ft, will see each other when still 320 ft apart. If instead the two cars are the latest low-slung models, with lines of sight only 48 in. above the pavement and the car tops not more than 8 in. higher, their distance apart, when they first sight each other, will be only 260 ft.

When it is considered that the late-model cars are likely to be traveling upwards of 60 miles an hour, and the Model-T's not over 45, the tremendous increase in the inherent dangers of the situation is obvious. A horrible accident that happened in one of the western states is only one of thousands of this type. A convertible came over a rise "on the wrong side of the road too fast to get back into its lane" and crashed into a truck carrying hot asphalt. Any of the occupants who may have survived the terrific crash were burned to death by the hot asphalt showered upon them by the force of the collision.

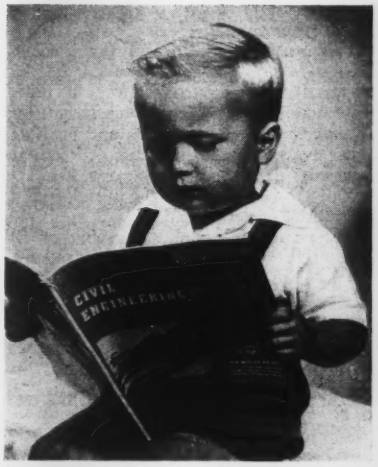
Highway engineers are perfectly aware of the importance of sight distance. Modern specifications call for rounding off the crests so that the sight distance will not fall below a certain minimum. In certain types of country this one item in the specifications may call for large expenditures. Yet no sooner is the new highway completed than it is rendered obsolete by the manufacturers' latest models, in which a complete redesign, achieved after an incredible amount of effort on the part of the designers, has permitted a further lowering of the overall height.

It is obvious that the danger at crests could be somewhat alleviated by requiring all vehicles to carry amber lights at least 6 ft above the ground, but there is another advantage of height that is even more important than being able to see over vertical curves, and it would not be helped a bit by such a requirement.

Many accidents are due to the driver's inability to judge distances and speeds correctly. Beyond a hundred feet or so, binocular vision is useless. Of the various methods of judging distances, that which relies on perspective is by far the best for the operator of a motor vehicle. If he is seated high up, as in most modern busses and in many trucks, his perspective is greatly improved. That the bus driver can put his huge vehicle down the highway at speeds of 70 miles an hour, meeting equally wide trucks with only a few inches to spare, and overtaking and passing vehicles with precision even though he does not have the ability to accelerate that the car owner has, makes him seem possessed of superhuman skill. He isn't. Move him down to the car driver's level and he wouldn't be able to do so well.

If there is any doubt as to the importance of vehicle and driver heights, the

"A future engineer"



Interested, but a little puzzled

TO THE EDITOR: While my son, John P. McCourt, J.M. ASCE, was in Europe this past summer, he had his copies of CIVIL ENGINEERING delivered to my sister's home in Ridgewood, N. J.

When the photographer was there to take a picture of my nephew, Jonathan Burgun, he handed him a copy of the September issue. I thought you might be interested in seeing how well the picture turned out. We call it "A Future Engineer."

ANN V. MCCOURT

Santa Barbara, Calif.

large number of high-seated trucks and busses on the road should provide a basis for gathering statistics. The writer recalls seeing a news item in which surprise was expressed over the results of a statistical study that showed that old-model cars were involved in fewer accidents, proportionately, than new-model cars. At present the accident rate for trucks is about one-fourth that for cars. Many factors enter, but part of the large difference could be driver-seat height.

Realization that sight has a lot to do with the highway safety problem has taken the form of increasing window areas to the extent that the driver can see all of his fenders. Useful as this may be in parking, it is of no value in high-speed highway driving.

C. J. POSEY, M. ASCE
Head, Dept. of Civil Eng
State Univ. of Iowa

Iowa City, Iowa

Why prestress new steel members?

TO THE EDITOR: An excellent example of the prestressing of new members with high tensile wire is given by Prof. G. Magnel in his article, "Long Prestressed-Steel Truss Erected for Belgian Hangar," in the October issue (p. 38). However, it is necessary to consider carefully whether there is in fact any practical advantage in this type of prestressing that would warrant its general use.

To prestress steel with hard drawn wire of 0.276-in. diameter—a material vulnerable to damage and even more vulnerable to corrosion—even if it results in some saving in initial cost, is to the writer's mind quite the wrong approach these days. The writer assumes that the wires are protected, but they are 45 ft above the ground.

It is undesirable to have bridges, roofs, or any other structure dependent on the effective protection of some vital part. It is undesirable to build such structures so that they need inspection and possible expensive renewal or painting at frequent intervals. These disadvantages are especially to be avoided if the initial saving is doubtful or very small.

Accepting the estimated saving of 12 percent in weight and 4 percent in cost for the truss described by Professor Magnel, it is possible that in the *average* case the cost of the stressing and the extra supervision would use up these savings. Even if the amount saved were doubled, it is doubtful whether it would be a "good buy," as a prestressed steel girder is not generally as good as one that is not prestressed. The deflection range is increased and the alternations of stress are increased.

It is quite a different thing to use high-tensile-strength bars to prestress existing steel girders. In that case there is usually a very real economy and the deflections are reduced; also bars of 1 in. or so in diameter are not so vulnerable and are a practical proposition for paint protection. Further, it is possible to use end connections of a type resistant to fatigue.

The writer is most sorry to disagree with Professor Magnel, whose article on this subject in *Ossature Metallique* the writer would recommend for its exceptionally good analysis of the basic principles of prestressing steel.

DONOVAN H. LEE, M. ASCE
Consulting Engineer

London, England

Costs of modernizing steam-electric plant discussed

TO THE EDITOR: The article by Marcel P. Aillery, "New York Transit Authority Modernizes East 74th Street Steam-Electric Plant," in the November issue, describes what is probably one of the most difficult power-plant rehabilitation projects ever attempted, and Mr. Aillery and his associates are to be congratulated on the manner in which they solved the many perplexing problems. The author should also be commended for including very complete cost data, which are so often absent in papers delivered before the engineering societies.

Referring to the costs as given in the paper, it is noticed that a cost of $45,000,000 is given for the first stage of modernization, which includes one 60,000-kw unit. This results in a unit cost of $750 per kw. As pointed out by the author, the first stage includes large expenditures for facilities which will be required for the final development of the plant and which will not be repeated. However, even if the additional boilers, turbines, etc., could be installed without any expenditure at all, the cost for the entire plant would be about $180 per kw, assuming that a total of four units would be installed as indicated in the paper.

Of course large expenditures will have to be made in order to complete the plant, which will probably bring the final cost to over $300 per kw, which appears high as compared with modern plants which are being built for around $175 per kw. This excessive cost is no doubt due to the congested area and the resulting problems. Would it not have been better for the Transit Authority to have obtained a site well suited for the building of a modern and efficient plant at a much lower cost and eventually to abandon the 74th Street location, which has many drawbacks for a modern plant? This, of course, would have required the shifting of the feeders from the plant to the new location. However, it is believed that this would not be insurmountable.

It would also be interesting to know why higher steam pressures and temperatures with steam reheat are not being used. These higher steam conditions would result in lower fuel consumption and are common in the metropolitan area, where fuel is high in price. It is realized that the load factor on the subway plants is low, due to the nature of the railroad load, which sometimes discourages the slight additional expenditures needed for a more efficient design. On the other hand, the rates for financing this project are low because of the low interest rates and the absence of taxes.

HERBERT B. REYNOLDS
Consulting Engineer

Jackson Heights, N.Y.

Author's reply

TO THE EDITOR: In arriving at costs per kilowatt, it must be remembered that a considerable amount of the $45,000,000 estimated cost of the "first-stage modernization" of the 74th Street Power Plant does not in any way reflect on the cost of the new 60,000-kw unit. Specifically, the replacement of all 25-cycle switching equipment, the new frequency converters and complete new coal and ash handling systems are improvements strictly for much needed reliability.

It has been estimated that the cost of the first 74th Street 60,000-kw (rated) unit is $337 per kw, that the incremental cost of the second 60,000-kw (rated) unit is $191 per kw, and that the average cost of the new 120,000-kw (rated) plant, consisting of two 60,000-kw units and three boilers, is $264 per kw. It is further estimated that complete modernization of the plant with the addition of two more units of the same capacity will lower the final average cost considerably below $264 per kw.

There are many factors which affect the cost of a power plant that have to be analyzed in making comparisons. Among such factors may be mentioned the following:

1. Cost of labor, materials and equipment at time plant is constructed.

2. Whether project is new and constructed on a relatively clear site, or whether the project involves the modernization of an existing operating plant.

3. Whether units are of moderate size (as at 74th Street) or whether they are of much larger generating capacity (as in the case of local metropolitan utilities).

4. Whether the design contemplates a so-called unit installation (single boiler to single turbine generator), or whether it contemplates the installation of 3 boilers for 2 turbine generators, thereby having excess boiler capacity to supply steam through a pressure-reducing station to old turbine generators (as at 74th Street).

5. Whether electrical energy is distributed locally at the voltage at which it is produced (as at 74th Street), or whether it is stepped up through transformers and tied in to an electrical network at considerably higher voltage (as in the case of many utilities).

6. The extent to which additional facilities are included in the project in order to assure absolute continuity of service, because of the possibility of panic and loss of human life which might result from a widespread loss of power in an underground transportation system.

The above factors, as they concern modernization of the 74th Street Power Plant, must be weighed carefully before making comparisons with any so-called yardstick.

Concerning the point Mr. Reynolds raised on steam pressures and temperatures, the equipment was selected not only with economic considerations in mind, but also for ability to operate successfully in carrying a typical, rapidly swinging, rapid-transit railway load.

M. P. AILLERY, M. ASCE
Chief Structural Engineer,
The J. G. White Engineering Corp.
New York, N.Y.

Sea-level canal at Panama seen as impracticable

TO THE EDITOR: With reference to Ole P. Erickson's discussion of the Panama Canal problem in the October issue (p. 66), may I add that the report submitted in the July 1954 issue, page 58, was prepared by men with long experience on the Panama Canal. While no one of this group was particularly qualified to discuss dredging techniques, their great knowledge of Canal prerequisites and potentials gives them an understanding of the problem that is far more valuable than any purely academic approach.

The proposal that work in Gaillard Cut be done by a hydraulic dredge with a 300-ft length and a 60-ft beam, with a hull depth of 20 ft, and a 210-ft ladder, to operate at 92 ft above mean sea level, and to dredge a channel through "andecite" rock for a 1,000-ft prism width at 50 ft below mean sea level, shows a vast lack of contact with operating conditions and geological structure between Gamboa and the Pedro Miguel Locks.

Mr. Erickson writes, "The hard rock could be drilled and shot as required for good pumping." It could be, but at what cost and over what a time period, as there are other controlling factors of tremendous importance! However, assuming that the drilling could be accomplished, what would restrain millions of cubic yards of material, containing over 25 percent of moisture by volume, from starting a flow of softer rock below the bottom of the Canal? This occurs all too frequently in the most unexpected areas during the rainy season.

It would be of interest also to inquire how millions of cubic yards of "andecite" rock could be fed in sufficient quantity in "the Cut" to a unit of the great capacity proposed by Mr. Erickson. It may be recalled that the best that could be accomplished by the "construction" dredging fleet in Gaillard Cut during the critical year of 1916 was 12,695,059 cu yd, of which only 1,822,550 cu yd was of earth—and the rock had to be excavated with dipper dredges.

Dredging restricted to Gaillard Cut must not be compared with work elsewhere, where there are large areas of water of more or less constant depth. In the Cut, the large size of equipment can in itself make it impractical, not to say expensive—a veritable Frankenstein. This was actually the case when the great ladder dredge *Corozal* was moved into "the Cut."

Mr. Erickson advocates a hull that is 20 ft in depth, which would demand spuds over 100 ft in length and of a diameter that would make replacements expensive indeed. If his unit were operating with the offshore spud down into 75 ft of water with the weight of the hull impacted against a 20-ft section as the enormous 210-ft ladder and giant cutterhead were hauled toward deep water, a spud might well break. That would require the 200-ton, revolving lock-gate crane to remove and replace it. This crane is not easily maneuvered in confined areas where variable water depths prevail. Imagination blacks out as one tries to estimate the weight and cost of such an element. And replacements would become nightmares if slides were blocking the channel. And where, nearby, could such a spud be stored for fast handling?

As prolonged discussion on Mr. Erickson's method of solving the problem at Panama appears unproductive when projected into operating costs and time required, permit me to reaffirm that the 17 men who christened the Sea Level Project "a monumental boondoggle" not only know the Panama Canal but cannot be more right.

It would seem more practical on every count to utilize the great horsepower and improved design of modern equipment to build a sea-level canal across Nicaragua. I believe that could be done in half the time and, even with today's dollar, at less cost than the same type of design at Panama.

RAY W. BERDEAU, A.M. ASCE
Consulting Engineer
Palm Beach, Fla.

Not the first time

TO THE EDITOR: In Mr. Thornley's article, "Compressed Concrete Pedestal Piles Form Foundation for Corlears Hook Apartment Project," in the December issue, the statement is made that:

"This foundation, . . . takes full advantage, for the first time it is believed, of the provisions in New York City's revised Building Code (1948) which permit the use of increased loads, up to 60 tons, for non-end-bearing piles. . . ."

The Raymond Concrete Pile Company has completed two jobs for the Hillman Housing Corporation adjacent to the Corlears Houses development using 60-ton Raymond piles in full compliance with the same sections of the code to which Mr. Thornley refers. The Hillman Housing Corp. is an affiliate of the owners of the Corlears Hook Apartment Project.

KIRBY SMITH, M. ASCE
Vice President, Raymond
New York, N.Y. *Concrete Pile Co.*

Reinforced brick masonry placed at faster rate

TO THE EDITOR: As director of the Department of Engineering and Technology of the Structural Clay Products Institute, the national association of brick and tile manufacturers, I wish to congratulate you on the excellence of your recent article, "Reinforced Brick Masonry Chosen for California V.A. Hospital," by Roy E. Guard, in the October issue.

We think it worth noting that, according to the masonry superintendent on the job, the bricklayer production at Sepulveda was not merely equal to production on standard masonry but greater than on unreinforced masonry. Norman W. Kelch, A.I.A. Technical Director of the Associated Brick Manufacturers of Southern California, has quoted "Swannie" Swanson, masonry superintendent for the general contractor, G. K. Newberg, as stating that the production of bricklaying per man per day was greater on this job of reinforced grouted brick masonry than on any similar job his firm has constructed in which unreinforced masonry was used. As an example, Mr. Swanson stated that 13 men, working 7 consecutive days, laid an average of 880 brick per man per day. Mr. Swanson indicated that this high production can also be attributed to the excellence of the V.A. building inspectors, good materials and equipment, and efficient job organization.

All the foregoing was reported to E. J. Thompson, Secretary-Treasurer-Business Agent, Bricklayers and Stone Masons Local No. 2 of California, who has granted permission to be quoted as vouching for the aforesaid statements.

HARRY C. PLUMMER, M. ASCE
Director, Eng. and Technology
Structural Clay Products Inst.
Washington, D.C.

SOCIETY NEWS

SAN DIEGO CONVENTION FEB. 6-11

Visitors to Hawaii who make the round of the various islands by plane will see trim pineapple fields (above) looking like colorful bedspreads from the air. The gentlemen at the right are putting final touches to the San Diego Convention program. They are ASCE Director M. J. Shelton, Convention Chairman Robert K. Fogg, and Philip W. Helsey.

Details are now available on some of the engineering projects in the San Diego area, which will be the objective of Saturday morning (February 12) field trips during the Society's forthcoming San Diego Convention.

The new Encina plant of the San Diego Gas & Electric Company at Carlsbad, Calif., which was placed in operation in November, has increased the capacity of the system by 106,000-kw. The company's expansion program, involving a present expenditure of more than $18,000,000 for the first unit and an ultimate expenditure of over $60,000,000, is based on the expectation of continued development of the area.

Unit No. 1 features a number of innovations in steam-plant design. The fuel burners are equipped to use either fuel oil or natural gas, and the boiler can be converted to coal. Another outstanding feature is the way in which the fuel oil (4,000 barrels daily) will be delivered—namely by oil tanker to a marine-unloading station about 3,000 ft offshore. A 20-in. line on the ocean bottom will carry the fuel oil pumped into it from the tanker to two 131,500-barrel tanks located near the plant.

Salt water for condenser cooling purposes will flow through intake tunnels from the Agua Hedionda Lagoon and lift it to the condenser by means of two 24,000-gpm pumps. The warmed water will be discharged through a tunnel into a surge basin located between Old Highway 101 and the lagoon. From the surge basin it will travel under the highway through a twin-barreled reinforced concrete structure to the ocean beach. This phase of the project involved dredging the lagoon to a depth of 8 ft below sea level over a 240-acre area.

For the benefit of those who decide on the Saturday morning trip to the Mission Valley yard of the Southwest Structural Concrete Corp. a prestressed tapered girder will be tested to failure, according to Robert C. Dorland, A.M. ASCE, chief engineer. The girder is 66 ft long and designed for a roof dead load of 200 lb per lin ft and a live load of 320 lb per lin ft.

Program in December Issue

The December issue carried the full San Diego Convention program, which will feature meetings of all the Society's Technical Divisions, several general sessions (two of them sponsored by the new Committee on Conditions of Practice), a promising social program that includes an evening in Old Mexico, and unlimited sightseeing opportunities.

Post-Convention Trip to Hawaii

For those fortunates who can get away for a winter vacation, the Hawaii Section is planning a combination meeting and tour carefully scheduled for the convenience of Convention-goers. The meeting will be on February 15, when the Section will be host at morning and afternoon sessions followed by cocktails and the native feast called the luau. The tour, which will take about ten days, will make the most of both scenic and engineering highlights of the islands.

Hawaii has craters, beaches, fern forests, lava-ash desert, coral reefs, sugar plantations, pineapple fields, ranches, and

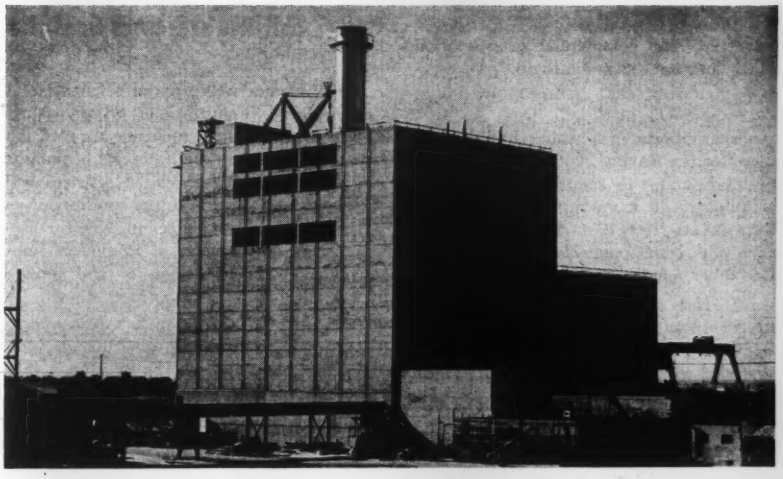
resorts. It is warm the year round at sea level but crisp in the mountains, with occasional snow on the tall peaks.

Formed by volcanoes, several of which still are active, the islands are a chain of peaks rising as high as 13,478 ft above the ocean. Six of these form a center of general industry and population—an area of more than 6,000 sq miles and 800 miles of coast. Living there are a half-million people representing a half-dozen races. English is the language of Hawaii, and the legal tender is standard American money.

Each of the islands has individuality in scenery, legend and history, yet none is more than an hour's air hop from its neighbor. At one end of the short series of Polynesian "stepping stones" is Kauai. Next is Oahu, then Molokai, Lanai, Maui and the "Big Island," Hawaii.

Resort areas are spread throughout the tropic chain, and by island-hopping visitors may relax in several recreation centers. An all-island trip nets a wide variety of scenic beauty and a vivid collection of Hawaiian lore. All beach resorts feature the outdoor life of surf and sun any season, and game fish are plentiful in the deep waters off half a dozen shores.

Hawaii's activity center is the island of Oahu, where Honolulu Harbor and International Airport are ports of call for trans-ocean liners and stratocruisers. From Oahu DC-3's and Convairs take off on local hops to the west, the east, the northeast and southeast, carrying inter-island commuters and travelers to landing fields scattered along the island chain.



New Encina plant of the Pacific Gas & Electric Co., which features a number of construction and operation innovations, will be one of the objectives of the Saturday inspection trips.

Inspection trips are tentatively planned for February 14, depending on the registration of mainland visitors. In any case, members of the Section will be on hand to show the visitors the points of interest. Travel and hotel reservation will be left to the individual members concerned. However, engineers planning the Hawaii trip should write to Mr. John R. Evans (chairman of the Hawaii Section meeting) at the University of Hawaii, Honolulu 14, Hawaii, so that preparations for the inspection trips can be made accordingly. The whole meeting program will be held at the Queen's Surf in Honolulu.

New York Offers Advantages for Engineering Center

New York's advantages as a site for the proposed Engineering Societies Center are set forth in a statement prepared by a task force of the Executive Committee of the Committee for a New Engineering Societies Building in New York. The report, dated October 27, 1954, has been submitted to the Committee of Five Presidents and to United Engineering Trustees (UET). The statement expresses the opinion that "the new engineering center should remain in its traditional home, New York City, where the Societies originated, progressed, and reached their present status of accomplishment over a century," and presents data in support of that opinion from prominent state and city organizations. The task force consists of R. E. Dougherty, ASCE, chairman; Malcolm Pirnie, Jr., ASCE, secretary; Kirby Smith, ASCE; R. W. Gillette, AIEE; J. S. Vanick, AIME; W. H. Byrne, ASME; and H. F. Roemmele, ASME.

In support of New York City, the report indicates that a preponderance of major engineering and consulting firms maintain their principal offices in that city, and gain among other advantages, "proximity to the financial interests which supply in large measure the funds needed" to build their projects.

Among the arguments for remaining in New York the report reminds that many engineers hope for the unification of the profession through Engineers Joint Council. It argues that much momentum already gained toward this objective would be lost if the Engineering Center Building should be located elsewhere.

One of the sites favored by the committee is near Columbus Circle. This site is at the northwest corner of 60th Street and Columbus Avenue, diagonally across Columbus Avenue from a two-block area on the Circle where New York's new Coliseum is under construction. The proposed site has a 241-ft frontage on Columbus Avenue and up to 250 ft on 60th Street. According to the report, the cost of the site to UET would probably not exceed $400,000. Here the facilities of the Coliseum, including an auditorium, meeting rooms, 850-car garage, and restaurants, and many nearby hotels, would be easily available. The entire area is being redeveloped under Commissioner Robert Moses, chairman of New York's Committee on Slum Clearance, of which Harry Taylor is director. The proposed site was offered to UET early in 1954. At that time Mr. Moses wrote the trustees, "I see no reason why business and industry in New York City interested in engineering and in retaining the engineering headquarters here could not provide financial aid."

As an alternative site, the report suggests that UET should "present a comprehensive investigation as to expansion of the present site (33 West 39th Street) and the reasons for deciding that it would not accomplish the purpose."

It should be remembered that, on November 15, UET recommended to the Founder Societies "that they decide to stay in New York." On learning of this recommendation, Herbert Hoover, Hon. M. ASCE, wrote, "I have long held that New York is the only city where the engineers can find a proper intellectual climate,

and the most facile association with the industrial and commercial groups with which they have so much to do."

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[Other reports on steps taken to develop a site for the Engineering Societies Center Building and the requirements for the building itself have appeared in CIVIL ENGINEERING for 1954 as follows: May, page 77; June, page 75; July page 68; December, pages 76 and 77.]

Engineers and Scientists Plan Nuclear Congress

With some twelve major scientific and engineering organizations participating, the country's first all-inclusive convocation devoted to peacetime problems of nuclear engineering and the related sciences will be held late this fall under sponsorship of the General Committee on Nuclear Engineering and Science of Engineers Joint Council. The chairman of the general committee is Dr. John R. Dunning, dean of engineering at Columbia University. Prof. Donald L. Katz, of the University of Michigan, is secretary and also chairman of the Program Committee. The American Chemical Society and the American Institute of Physics have voted to join the EJC General Committee in sponsoring the congress.

Another major participant in the congress will be the recently organized American Nuclear Society, which as a preliminary to the congress will hold its first annual meeting and technical conference at Pennsylvania State University, State College, Pa., June 27–29. Jerome D. Luntz, editor of *Nucleonics Magazine* and a founder of the society, is a member of the EJC General Committee on Nuclear Engineering and Science, and James A. Lane, chairman of the American Nuclear Society Program Committee, will join the EJC Program Committee in drawing up the congress program. The Nuclear Congress will be held in Cleveland, Ohio, the week beginning December 12.

An international discussion of peacetime uses of atomic energy—to be held as a United Nations project at the urging of President Eisenhower—is expected to take place in Europe in August. The papers coming out of this gathering may have a bearing on the Nuclear Congress program. Technical papers will be presented by participating societies through their divisions or committees. In addition to providing a means of presenting authorized discussions, the congress is expected to "initiate a vitally important new literature through the subsequent publication of worthwhile papers and addresses in a field which cuts across all areas of engineering and science."

Copies of Code of Ethics Available

American Society *of* Civil Engineers

Code of Ethics

It shall be considered unprofessional and inconsistent with honorable and dignified bearing for any member of the American Society of Civil Engineers:

To act for his clients or for his employers in professional matters otherwise than as a faithful agent or trustee, or to accept any remuneration other than his stated charges for services rendered his clients.

To attempt to injure falsely or maliciously, directly or indirectly, the professional reputation, prospects, or business of another Engineer.

To attempt to supplant another Engineer after definite steps have been taken toward his employment.

To participate in competitive bidding on a price basis to secure a professional engagement.

To compete with another Engineer for employment on the basis of professional charges, by reducing his usual charges and in this manner attempting to underbid after being informed of the charges named by another.

To review the work of another Engineer for the same client, except with the knowledge or consent of such Engineer, or unless the connection of such Engineer with the work has been terminated.

To advertise in self-laudatory language, or in any other manner derogatory to the dignity of the Profession.

To use the advantages of a salaried position to compete unfairly with Engineers in private practice.

To use undue influence or offer commissions or otherwise to solicit professional work improperly, directly or indirectly.

To act in any manner or engage in any practice which will tend to bring discredit on the honor or dignity of the Engineering Profession.

The Society's Code of Ethics, shown here in facsimile, assumes new importance in view of the current interest in bidding for professional services. Copies printed on 8 1/2 × 11-in. paper suitable for framing are available to members without charge on request to the headquarters office of the Society.

ASCE Defers Decision On Engineering Center

Pending receipt of the expected report from the Committee of Five Presidents, due soon after February 1, the Executive Committee of ASCE at its meeting in Santa Fe on December 10 decided to defer action on the UET recommendation to stay in New York (December issue, pages 76–77). It instructed the Executive Secretary of ASCE to prepare a comparative statement of the probable annual cost to ASCE of a new Engineering Societies Center Building for each of the five proposed locations—Chicago, New York, Philadelphia, Pittsburgh, and Washington.

Column Research to Yield Safer, Cheaper Structures

During the past six years a fund of new and valuable information on the behavior of columns has been accumulated in an active research program conducted by the Column Research Council, an Engineering Foundation sponsored project. In the light of the Council's findings, the jesting reference to the engineers' "factor of safety" as a "factor of ignorance" turns out to be anything but a jest. All engineers know that because of the inadequacy of our knowledge most structures are overdesigned, with resulting waste of material. They also know that, despite the overdesign, an occasional structure fails. To increase knowledge in the field, so that even the infrequent failures can be eliminated and, at the same time, to conserve the materials now wasted by overdesign, two courses are open. In the one the competent and aggressive engineer can stick his neck out and design to a narrower margin of safety. The other course involves the more certain but more expensive method of controlled experiment.

Columns, the basic load-bearing members of most structures, have long been designed by formulas based on tests on small structures. These tests, however, bear little relationship to the modern structures to which the formulas are applied. Engineers have been aware of the problem, but have realized that the studies and experiments needed to provide a basis for safer and more economical design were beyond the scope of any single individual or organization. It was to cope with the situation that the American Society of Civil Engineers proposed the formation of a column Research Council. With the sponsorship and financial assistance of the Engineering Foundation, the Council was organized in 1948. Since that time the Council has been under the chairmanship of Shortridge Hardesty, Hon. M. ASCE, and senior partner in the consulting firm of Hardesty and Hanover.

As a first step in formulating a rational research program, the Council sought information from a large and representative group of structural engineers as to the problems in column behavior, and in the buckling of metallic parts in general, which most needed solution. The research projects undertaken by the Council with the results of this survey in mind will ultimately lead to the revision of existing design formulas.

Typical of the Council's researches is the work that has been carried on during the past year on twelve projects at nine universities. These projects include columns in continuous frames; buckling of rigid-joint structures; analysis and design of columns in trusses and frames; effect of initial eccentricity on column capacity; built-up columns; lateral buckling of channels I-beams, and Z-beams; inelastic instability; torsional buckling of columns; lateral buckling; interaction of compression and bending forces; stability of bridge chords without lateral bracing; and the influence of residual stress in rolled columns.

It is expected that all these projects will be considered by the Council's new Committee on Practical Applications, and that most of them will yield recommendations for future design practice. The Committee on Practical Applications was set up in 1953 when it seemed that the time had come to give more emphasis to the practical application of the results of the Council's researches. Jonathan Jones, Hon. M. ASCE, and retired chief structural engineer of the Bethlehem Steel Company, was made chairman of the committee.

Commenting on the aims and activities of the new committee, Mr. Jones stated that, "In the design of compression members we have to a large extent coasted along, using rules and formulas derived from experiments made and deductions drawn long ago. We have established the rules either for average cases, meaning that some structural sections are not as well protected as they should be, or we have established them for the 'worst case,' thus wasting material in applications less severe."

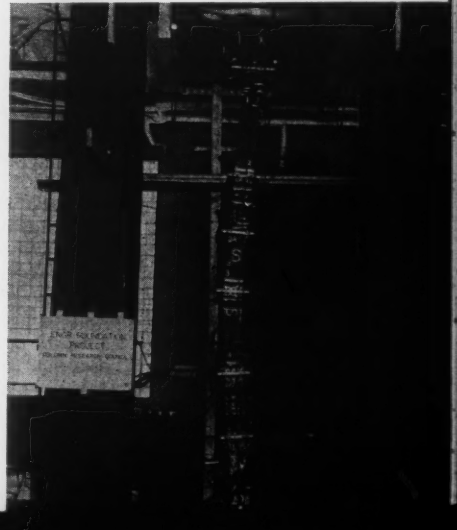
According to Mr. Jones, this situation was not too bad "when designing was largely in the hands of experienced engineers who could take responsibility for departing from conventional rules when they considered it necessary. But as of today these rules have very generally been frozen into law through building codes and formal contracts. Furthermore, designs are often made by and under the direction of men who have had no connection with the formulation of the rules, and a departure from these rules is not expedient and, in many cases, not legally permissible"

As typical examples, Mr. Jones cites "the 'column formulas' of the American Railway Engineering Association for compression members in bridges, and of the American Institute of Steel Construction for those in buildings." The AREA formula was derived theoretically from a limited number of comparatively small-scale tests on single columns. Mr. Jones points out that this result holds good only for a specific set of end conditions. However, the resulting formula was applied to various structural members, and to individual sections, and the AISC formula was later adapted from it to permit lower factors of safety in buildings.

It is generally conceded, says Mr. Jones, that these formulas have the virtue of simplicity and that there generally has been some factor of safety wherever they have been applied. Most engineers, however, recognize that in the interest of obtaining greater safety for the same money, or the essential safety for less money, these simple rules should be restricted to the cases they fit best and be supplemented by additional or different rules to cover other important conditions.

The Council's research program has been planned to meet this situation, and during the six years that it has been under way much valuable new information has been developed. According to Mr. Jones, the new Committee on Practical Applications "without doubt... should soon be able to define practical applications of, and recommend rules of practice for, the work that the Council has been doing in the field of compression members for bridges and buildings."

The Column Research Council is an excellent example of cooperative research on a problem of interest to widely differing groups. It is also an excellent example of an Engineering Foundation project. In addition to playing its typical catalytic part in getting the Council started, Engineering Foundation has continued to sponsor and support it and has contributed $20,500 to its organization and subsequent research work. As with most Foundation-sponsored projects, however, the major portion of the funds for the Council's

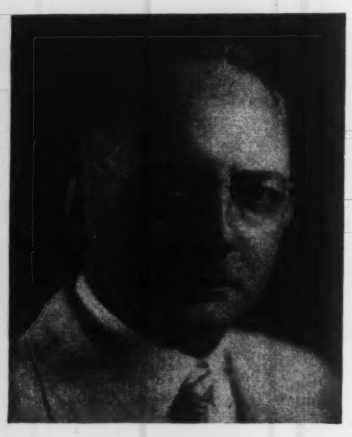


The effect of initial eccentricity on the strength of a column is investigated in the Fritz Engineering Laboratory at Purdue University. This shows the column after failure.

program ($170,000) has been contributed by industrial companies and organizations directly concerned with improved structural design.

The Council itself is a technical board of some fifty members representing technical societies, trade groups, and industries. It meets annually in New York City for two or three days in May to hear its various committees report and to plan future work. The Council's headquarters are at Lehigh University, Bethlehem, Pennsylvania, and Lynn S. Beedle, A.M. ASCE, assistant director of the Fritz Engineering Laboratory there, is its secretary.

Ernest E. Howard Award Established by ASCE



Ernest E. Howard

ASCE has established a new award in honor of the late Ernest E. Howard, President of the Society in 1950. Mr. Howard, senior partner in the Kansas City, Mo., and New York consulting firm of Howard, Needles, Tammen & Bergendoff, died in Kansas City on August 19, 1953. The award, consisting in part of a medal sculptured by Thomas Hart Benton, has been made possible by funds donated by his widow.

The Ernest E. Howard Award, details of which will be developed, will be made annually "to recognize a civil engineer who has made a definite contribution to the advancement of structural engineering through either writing or performance." It will apply to "outstanding contributions to structural engineering, either in research, planning, design, or construction, including methods and materials; these contributions to be made either in the form of papers or other written presentation, or through notable performance or specific actions which have served to advance structural engineering."

Mr. Howard's firm has been responsible for some of the most notable bridge and turnpike achievements in this country. Joining ASCE in 1905, Mr. Howard was a Director and Vice-President before becoming President.

EJC to Discuss Manpower at First General Assembly

Development of a program for its first General Assembly; initiation of a procedure for obtaining adequate honors for outstanding engineers; a move to invite more organizations to membership; designation of a representative to UNESCO, and nomination of officers are activities coming out of a recent meeting of the board of directors of Engineers Joint Council in New York.

The General Assembly, to be held at the Hotel Statler in New York on January 21, will have as its basic theme the increase of unity in the profession. The program will start at 9:30 a.m. and run through the evening. Thorndike Saville, dean of engineering at New York University and president of EJC, will preside. Dr. John R. Dunning, dean of engineering at Columbia University, will be chairman of an open forum on nuclear developments as they affect the engineering profession. EJC's proposed Nuclear Engineering and Science Congress scheduled for the fall (item elsewhere in this department) will also be discussed during the forum. Dr. Dunning is general chairman of the new EJC General Committee for Nuclear Engineering and Science.

A panel on "Employment Conditions and Unionization—Their Effect on the Engineer" will be headed by G. Brooks Earnest, president of Fenn College, Cleveland, and former Vice-President of ASCE. Other panel members and their subjects are Arthur K. Doolittle, assistant director of research, Carbide & Chemical Corp., on "Engineering—A Profession"; Nathan W. Dougherty, dean of engineering, University of Tennessee, on "Is Collective Bargaining Compatible with Professionalism?"; and E. Lawrence Chandler, Assistant Secretary of ASCE and treasurer of EJC, on "Responsibility of Management and the Employee in the Engineering Profession."

The luncheon speaker will be John F. Hilliard, Deputy Assistant Director for Manpower, Office of Defense Mobilization, Washington, D.C., on the topic, "Engineers and Our National Well Being." As a logical follow-up to Mr. Hilliard's talk, the first afternoon forum will be on engineering manpower. Dr. Thomas H. Chilton, technical director, E.I. du Pont de Nemours & Co., and chairman of the Engineering Manpower Commission, will be chairman. Another afternoon forum discussion—on "The EJC Objectives"—will be headed by Carlton S. Proctor, Past-President of ASCE and New York consultant. The assembly will close with a banquet, at which the featured speaker will be Ronald A. Quarles, Assistant Secretary of Defense for Research and Development.

Free tickets for the day's program may be obtained from Engineers Joint Council, 29 West 39th Street, New York 18, N.Y.

UET Elects 1955 Officers

James L. Head was reelected president of United Engineering Trustees, Inc., at the organization's fifty-first annual meeting held on October 28. He is a mining engineer with the Anaconda Copper Mining Co. Other officers elected were W. J. Barrett, New Jersey Bell Telephone Co., vice-president: W. F. Thompson, vice-president of Westcott & Mapes, Inc., vice-president; Waldo G. Bowman, McGraw-Hill Publishing Co., treasurer; Joseph L. Kopf, president of Jabez Burns & Sons, assistant treasurer; and John H. R. Arms, secretary. Mr. Arms has been secretary and general manager since 1933.

Index to 1954 "Civil Engineering" Ready Soon

The index to Volume 24 of CIVIL ENGINEERING will be ready February 1 and will be available without charge to members wishing to incorporate it in their bound volumes. A postal card request to Society Headquarters will suffice.

Single copies of the index are sent to all subscribing libraries. Extra copies are available on request.

NOTES FROM THE LOCAL SECTIONS

(Copy for these columns must be received by the tenth of the month preceding date of publication.)

Underground water tables in southern and central Arizona have dropped as much as 18 ft during the past year, Leonard C. Halpenny, district engineer of the U.S. Geological Survey at Tucson, brought out in one of the technical talks at the **Arizona Section's** fall meeting, held in Phoenix in November as part of the sixth annual Joint Engineers Meeting. In 1953, he said, 4,800,000 acre-ft of water was taken from underground sources—an amount equal to four times the average annual flow of the Salt and Verde rivers combined. Other technical papers were given by C. M. Corbit, district engineer for the American Institute of Steel Construction at Los Angeles, who explained the AISC specifications for allowable bending stresses in continuous beams and columns, and H. Z. Andrade, of the General Electric Co., who discussed the heat pump. A new slate of officers was installed during the Section's business meeting. They are Hanen H. Williams, Phoenix, president; E. J. Maggi, Phoenix, first vice-president; Wilbur L. Heckler, Tucson, second vice-president; and Robert M. Cushing, Tempe, secretary-treasurer. Other Section members coming in for honors were Hugh S. Allen, E. S. Borgquist, and Clyde Myers, who received their life membership certificates at the Section's annual luncheon.

Members of the **Buffalo Section** had the thrills without the discomforts of a trip to the Antarctic at their November meeting when James H. Holcombe, executive officer for the Buffalo District of the Corps of Engineers, described Admiral Byrd's last trip to Scott Island in 1946 and 1947 in a talk entitled "Operation Highjump." Colonel Holcombe, who represented the Chief of Engineers on the expedition, discussed the difficulty of building airplane runways in the extremely granular snow. Incidentally, temperatures during the three summer months of January, February and March ranged from +30 to −27 deg F!

Three **Central Illinois Section** members and two guest engineers made up a panel of speakers on collective bargaining for professional employees at a recent dinner meeting in Urbana. A number of aspects of the troublesome problem were covered by the experts—Section Members J. W. Briscoe, W. S. Pollard, and E. J. Daily (all on the University of Illinois engineering staff), and L. C. Pigage, of the Institute of Labor and Industrial Relations at the university, and Eugene Easley, superintendent of plant engineering for the Allison Division of General Motors at Indianapolis. The session was moderated by J. C. Dietz, Jr., professor of sanitary engineering at the university.

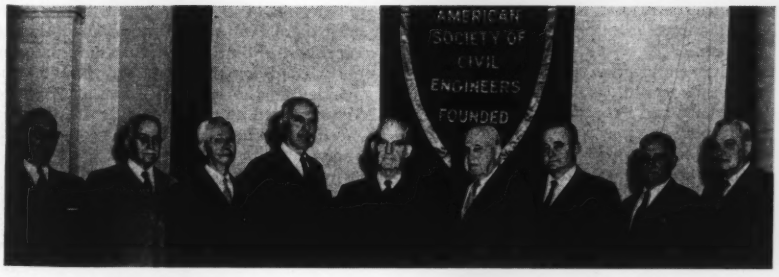
Successful measures to conserve the water resources of the Miami Valley in Ohio were outlined by B. Remmeling in one of two featured talks at the November meeting of the **Cincinnati Section.** Mr. Remmeling emphasized that flood protection from the Little Miami River was accomplished entirely by the residents of the valley "without help from state or federal government." The second speaker, Robert Lewis, discussed a project of the South Western Water Co. to obtain adequate water supplies for its industries from the Great Miami River.

A request from the Power Division for assistance with its papers was discussed at the **Connecticut Section's** November meeting. The guest speaker, Lt. Frank Chameroy, of the Connecticut State Police Department, gave an illustrated talk on the activities of the Identification Bureau of the department.

Communications intended for the **Central Savannah River Valley Subsection** of the **Georgia Section** should now be addressed to P. J. Masiocchi, 2425 McDowell Street, Augusta, Ga. C. H. Topping, senior architectural and civil consultant for E. I. du Pont de Nemours & Co., spoke at a recent joint meeting of the Subsection and the South Carolina Society of Engineers on how his company selects a plant site.

The **Hawaii Section** has initiated a drive for new members with what it calls "spectacular results." Roy Iwamoto, a recent graduate of the University of Hawaii, has been awarded Junior Membership in the Society by the Section's Committee on Engineering Education.

The program at a recent joint meeting of the **Intermountain Section** and the Ogden Engineers Club consisted of a talk



Traditional features of the District of Columbia's annual meeting are pictured here. Shown immediately above, in usual order, are the Section's new life members who received their certificates from ASCE President W. R. Glidden. They are Frank S. Borden, Richard T. Evans, Clement L. Garner, Gavin Hadden, Mr. Glidden, Robert F. Luce, John L. Nagle, Frank L. Weaver, and Herman P. Hevenor. Capt. A. L. Ort and Harry E. Horstmyer were in Europe and unable to receive their certificates in person. The other photo shows the presentation of student awards to three outstanding members of three Student Chapters in the Washington area with the deans of their schools. Reading left to right are Dean Martin A. Mason and Stuart T. Terrett, 3rd, George Washington University; Boyd P. Strain, Jr. and Dean Louis K. Downing, Howard University; and Dean Thomas K. Killian and William T. Kellerman, Catholic University of America. New Section officers, elected during the meeting, are George E. Tomlinson, president; Bernard F. Locraft, vice-president; Francis J. Flynn, secretary; and Theodore M. Schad, treasurer.

Viewed at the annual meeting of the Iowa Section, held at Des Moines on November 18, are (seated, left to right) Joseph W. Howe, vice-president, Iowa Section; Dean F. M. Dawson, ASCE Director, District 16; Glenn H. Doty, president of Section; and Prof. Lowell O. Stewart, long-time secretary-treasurer. Standing, in the same order, are Section Director Robert Zack and Neil Welden, recent past-president.

Henry LeToile (center), assistant to the president of the contracting firm of B. Perini & Sons, and principal speaker at a recent Northeastern Section meeting, is shown here with Section officers—Vice-President Emory Ireland (left) and President John Wilbur. Mr. LeToile described the construction of the twin 5½-mile hydro-tunnels recently completed by his company for the Ontario Hydroelectric Co. at Niagara Falls. There were about 75 present.

on the industrial development of the Ogden area. Daniel D. Dale, manager of the Weber County Industrial Bureau, was the featured speaker.

Engineering in the Panama Canal Zone was described by Howard M. Gifft, head of the sanitary engineering department at Cornell University, at a recent joint dinner meeting of the **Ithaca Section** and the Cornell Student Chapter.

The boundaries of the **Kansas Section** have been enlarged to include Wyandotte and Johnson counties, formerly in the Kansas City Section. In November the Section had two joint meetings—with the Kansas State College Student Chapter at Manhattan and the Salina Engineers Club at Salina—and heard L. E. Conrad, professor emeritus of civil engineering at Kansas State, describe a recent year in Formosa, and O. O. Ediger, president of the Ediger Engineering Co., who discussed the new Wichita Municipal Airport.

New **Kentucky Section** officers are G. R. Watkins, president; J. E. Heer, Jr., vice-president; W. B. Drake, secretary-treasurer; and C. W. Pemble, Jr., corresponding secretary. At the installation meeting, on December 3, R. R. Dawson, president of the Dawson Bridge Company, showed his construction film on the new Cumberland River Bridge.

The Structural Group of the **Los Angeles Section** heard a spirited discussion on trends in engineering education at its annual business meeting on November 10. One educator from each of the three engineering schools in the Los Angeles area made up the panel of speakers: George W. Housner of Cal-Tech; David Wilson of USC; and J. Morley English of UCLA. Donald Shugart, a structural engineer in private practice, also contributed importantly to the panel. He suggested extending the span of the engineer's formal education from four to six or even seven years in order to include more time for the humanities and fine arts, which he considers essential to effective professional functioning. There was pretty general agreement that there is room for improvement in the high schools of the country. Program Chairman John Minasian acted as moderator. New Structural Group officers are: John Case, chairman; Jack Martin, vice-chairman; Dick Gerke, secretary-treasurer; and John Minasian and Harold Omsted, directors.

William P. Kimball, dean of the Thayer School of Engineering at Dartmouth College, was elected president of the **New Hampshire Branch** of the **Maine Section** at its annual meeting held in Concord on November 22. Russell Skelton, professor of civil engineering at the University of New Hampshire, was reelected vice-president, and Frederick T. Comstock, Jr., of Boscawen, was chosen secretary-treasurer. The attendance of over 60 members and students heard Laurence Whittemore, president of the Brown Co. and director of a number of New England industries, discuss soundly educated engineers as an asset to the free world.

ASCE MEMBERSHIP AS OF DECEMBER 9, 1954

Members	8,762
Associate Members	11,212
Junior Members	17,753
Affiliates	69
Honorary Members	44
Total	37,840
(December 9, 1953	36,808)

Members of the **Maryland Section** were given a good briefing on the St. Lawrence Project at their November meeting by Raymond F. Stellar, chief engineer of the St. Lawrence Seaway Development Corp. Both the power and waterway phases of the project were covered by Mr. Stellar, who was engaged on early studies and plans for the project in the Office of the Chief of Engineers. He said that distribution of power from the development is expected to begin by September 1958 and that navigation on the seaway will start either late in 1958 or in the spring of 1959.

"Amazing progress" toward a unified building code for the South Florida area was reported at the November Meeting of the **Miami Section** by George Headley, chairman of the Building Officials Committee of Southeast Florida and principal speaker. Pointing out that only one code is needed for the area, Mr. Headley appealed to the various professional groups represented at the meeting to throw their weight behind the proposal for a unified code.

New officers for the **Mid-South Section's Memphis Branch,** elected by acclaim at a meeting on November 26, are O. M. Carter, president; James B. Ellers, vice-president; and Fred C. Walpole, secretary-treasurer. An informative talk on Waterways Experiment Station operations in Greenland was given at the Vicksburg Branch's dinner meeting with the ladies on December 2. The speaker was Charles R. Foster, chief of the Station's Flexible Pavement Branch. Hunter Rouse director of the Iowa Institute of Hydraulic Research, was a guest of the group.

Downtown parking must be regarded as an economic problem, Allen Voorhees, executive director of the Automotive

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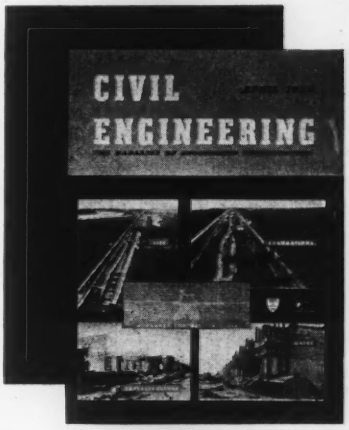

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Assembling at Yakima, Wash., for the fall meeting of the Pacific Northwest Conference are J. Byron Barber, secretary-treasurer; Fred H. Rhodes, past chairman; Harold J. Doolittle, chairman; ASCE Director Glenn W. Holcomb; and Horace J. Whitacre, vice-chairman. Mr. Holcomb reported on recent activities of the Board of Direction, and there was a Local Section Conference with C. C. McDonald as coordinator.

Safety Foundation, Washington, told a recent traffic conference in Albany conducted by the **Mohawk-Hudson Section.** Mr. Voorhees said that downtown retail stores depend on adequate parking facilities, and recommended that such stores establish parking lots or garages for shoppers in their immediate vicinity on a fee basis. Other speakers included Maynard A. Beebe, of the State Department of Public Works; Adm. Lewis B. Combs, U.S. Navy (retired); and Bernard A. Lefeve, director of the highway planning for the State Department of Public Works.

The **Montana Section's** officers for 1955, elected at its annual meeting in Great Falls, are O. C. Reedy, president; Thomas Hurdle, vice-president; and Lawrence F. Whearty, secretary. Mr. Reedy, who is chief of the Programs and Reports Branch of the Bureau of Reclamation's Region 6 at Billings, was the principal speaker with a talk on a recent engineering assignment to the Philippines.

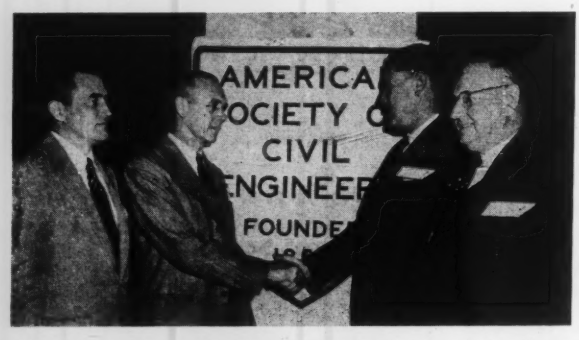
The congratulations of the **Nashville Section** and a check for $10 have been sent to Cooper McRae, senior civil engineer at T.P.I., for coming up with the winning title in the Section's contest to name its new publication. Previously nameless, the bulletin is now called *A Level Line from Nashville Section.* Voting by letter ballot, the Section has elected its 1955 officers: A. J. McElrath, president; Dan B. Barge, Jr., vice-president; and Louis C. Daugherty, secretary-treasurer. New Life Member designates are R. N. Coolidge, Ivor Livingston, R. C. Pierce, and W. A. Vaught.

The **Nebraska Section** has adopted a resolution calling for the restoration of a professional classification in the U.S. Civil Service System. At a recent joint meeting with the University of Nebraska Student Chapter, Prof. George C. Ernst, head of the civil engineering department at the university, discussed the effect of a revival "of the plastic theory of reinforced concrete design on current teaching practice now dominated by the elastic theory." He expressed the hope that "a more realistic design approach may be achieved by the intelligent use of both theories in their proper range of application."

An important new Albuquerque structure, the Simms Building, was discussed and inspected in detail at the **New Mexico Section's** fall meeting, held at the University of New Mexico on October 23. Max Flatow, architect for the structure, and Frank Bridgers, mechanical engineer of Albuquerque, were the speakers. New Section officers are Gordon E. Kerkenhoff, president; Arthur A. Mosher and Ray J. Foss, vice-presidents; and Rufus H. Carter, Jr., secretary-treasurer.

A News Letter and an attractive one has been launched by the **Northwestern Section.** Its principal purpose will be to act as an "integrating medium" for keeping Section members fully aware of what is going on within their own boundaries. F. J. Ryder is publication chairman, and the members will be the contributing editors. In the principal talk at the November meeting, J. H. Heron, superintendent of motive power for the Great Northern Railroad, discussed the rapid dieselization of American railroads in the past twenty years. He said that railroads dieselize, first, because of the economic advantage and, second, because of the speedier and more flexible operating schedules permitted.

Problems involved in establishing a national water policy were outlined by Ralph



Chattanooga welcomes the Tennessee Valley Section for its annual meeting, to which the Sub-Section in that city was host November 5 and 6. Shown here (left to right in left-hand view) are Don P. Reynolds, Assistant to the Executive Secretary, who brought the greetings of the Society to the group and spoke on civil engineers as "the builders of the profession"; Graham P. Willoughby, ASCE Director and dinner meeting speaker; Mayor P. R. Olgiati;

and Wilkes T. Thrasher, county judge for Hamilton County. During the dinner Life Membership Certificates were presented to Maj. Thomas A. Cox, Jr., Herbert E. Hudson, and Robert A. Monroe. The right-hand photo shows newly elected officers (seated) Vice-President Ross N. Brudenell and President Roy J. Morton. Standing in the same order are A. B. Goodwin, 1954 vice-president; John C. Voorhees, 1954 president; E. M. Titus, secretary-treasurer.

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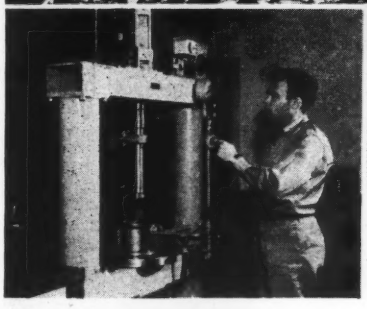

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Columbus 15, Ohio Tucson, Ariz. Seattle, Wash. Baton Rouge 2, La. St. Louis 17, Mo.
Inglewood, Calif. Oakland 1, Calif. Portland 7, Ore. Washington 5, D. C. San Juan 23, P. R.

Top brass in attendance at the annual meeting of the West Virginia Section in Charleston on November 5 is shown here. Seated, in usual order, are ASCE Vice-President Frank L. Weaver; President W. R. Glidden; and George S. Richardson, Director for District 6. Standing, in same order, are George W. McAlpin, former Director from District 6; Washington Representative Joseph H. Ehlers; and Fred R. Palmer, president of West Virginia Section.

Tudor, San Francisco consultant, at the **Oregon Section's** November meeting. Mr. Tudor, who was until recently Undersecretary of the Interior, reported progress made to date in the matter. The Section has voted to invite the Society to Oregon for its 1958 Summer Convention.

The **Philadelphia Section's** double-header program, on November 9, consisted of a detailed description of the construction and operation of the new ore-unloading pier in South Philadelphia, the largest in the East, and a discussion of slum-clearance planning in the city. The speakers were J. E. Smith, assistant chief engineer for the Eastern Region of the Pennsylvania Railroad, and Aaron Levine, executive director of the Citizens' Council on City Planning.

At a recent joint meeting of the **Pittsburgh Section** and its **Junior Branch**, three Junior Members—Dr. Thomas E. Stelson, Joseph P. Murtha, and Fred A. Richards—were the speakers. Under the topic, "Dynamics in Engineering," the young men described problems they are working on at Carnegie Institute of Technology. At another joint meeting—this one with the Civil Section of the Engineers' Society of Western Pennsylvania—the speaker was C. D. Palmer, president of the Pittsburgh Railways Co., and his subject "Problems of Mass Transportation." Charles M. Wellons has been elected Section president for 1955, and E. D'Appolonia, vice-president. Robert B. Pease remains as secretary-treasurer.

Problems arising in the design and construction of Idlewild Airport were discussed at the **Providence Section's** November meeting by John M. Kyle, chief engineer of the Port of New York Authority. There were thirty-five present.

Clarence H. Ax was elected president of the **St. Louis Section** at its annual meeting on December 3. Other new officers are Neal Campbell and Eldred Murer, vice-presidents; Robert Smith, secretary; and L. Roth, treasurer. The Section, with its membership of 500, will be host to the ASCE Convention in June.

Certificates of life membership were presented to George N. Carter and Thomas F. Newell at a meeting of the **Southern Idaho Section** in Boise on December 3. The principal speaker was Dr. G. Victor Beard, chief of the Health and Safety Branch, Idaho Operations Office of the Atomic Energy Commission, who spoke on radiation as a result of fission and demonstrated the ability of alpha, beta, and gamma rays to penetrate various materials. Guests at the meeting included high school students who are members of the "Future Engineers Club" of the Boise High School.

An inspection tour of the new Toledo Express Airport in October initiated a new season of **Toledo Section** activities. John Alspach, service director, and Arnold Finch, former city manager, explained the project, and there was a general and lively discussion of bidding for engineering services for highway work at the dinner meeting following the tour. George A. Fasold, director of research for the Philip Carey Mfg. Co., Cincinnati, was the speaker at the November meeting.

Research in structural steel was discussed at the **Wisconsin Section's** November meeting by T. R. Higgins, director of engineering for the American Institute of Steel Construction. Mr. Higgins' talk covered fireproofing of structural members, design of steel beyond yield-point strength, and the use of high tensile strength bolts.

Coming Events

Hawaii—All day meeting at the Queen's Surf, Honolulu, February 15.

Kentucky—Luncheon meeting with the Kentucky Society of Professional Engineers at the Brown Hotel in Louisville, January 22, at 12 noon.

Los Angeles—Dinner meeting at the Rodger Young Auditorium (936 West Washington Blvd.), January 12, at 7 p.m.; dinner meeting of the Junior Forum in the Rodger Young Auditorium, January 12, at 6 p.m. Meeting of the Transportation Group in the State Highway Building (120 South Spring Street), January 19, at 7:30 p.m.; dinner meeting of the Soil Mechanics Group at Taiix French Restaurant (321 East Commercial Street), January 19, at 6:30 p.m.; and dinner meeting of the Sanitary Group at Taiix French Restaurant, January 26, at 6:30 p.m.

Metropolitan—Meeting in the auditorium of the Engineering Societies Building, 33 West 39th Street, January 19, at 7 p.m.; meeting of the Junior Branch in Room 501 A, Engineering Societies Building, January 19, at 7 p.m.

Philadelphia—Dinner meeting at the Philadelphia Engineers Club, January 11, at 6:30 p.m. Program will feature presentation of Life Membership Certificates to 21 members.

Sacramento—Weekly luncheon meetings at the Elks Temple every Tuesday at 12 noon.

South Carolina—Annual winter meeting at the Columbia Hotel, Columbia, S.C., January 21, at 10 a.m.

Milwaukee—Dinner meeting in the Engineering Societies Building in Milwaukee, January 27, at 6:30 p.m., with Assistant Secretary E. Lawrence Chandler speaking on "Collective Bargaining," with particular emphasis on its relationship to the engineering profession.

Scheduled ASCE Conventions

SAN DIEGO CONVENTION
San Diego, Calif.
Hotel U. S. Grant
February 6–11, 1955

ST. LOUIS CONVENTION
St. Louis, Mo.
Jefferson Hotel
June 13–17, 1955

NEW YORK CONVENTION
New York, N.Y.
Hotel Statler
October 24–28, 1955

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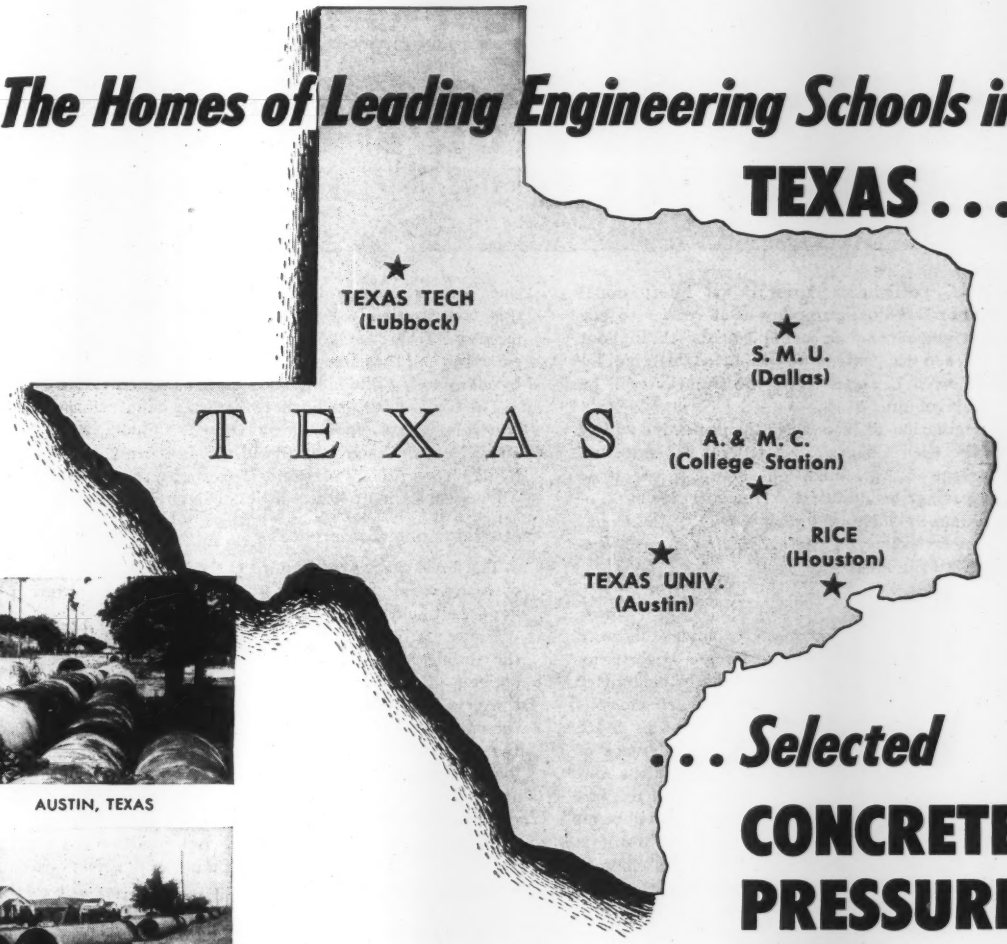
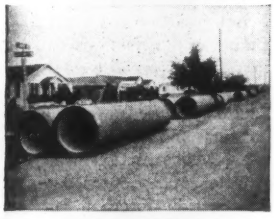
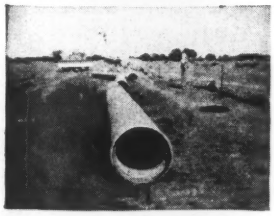


AUSTIN, TEXAS



LUBBOCK, TEXAS



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FROM THE NATION'S CAPITAL

JOSEPH H. EHLERS, M. ASCE — Field Representative ASCE

The national spotlight is currently on international affairs and basic U.S. foreign policy as it relates to our own military and economic commitments throughout the world. When the extent to which engineering interests are involved becomes clear, the situation will be discussed in this column.

Domestic legislation of interest to the profession will be debated by the 84th Congress. A federal pay-raise bill will be introduced. Agreement on some features is so general that passage is indicated. However this type of legislation ordinarily advances very slowly. ASCE has adopted a general policy on the subject which was presented to the 83rd Congress.

Highway Policy

The President's program for vastly expanded highway construction will be a headline issue for the engineering profession and the construction industry. The committee headed by General Clay has reached some conclusions which the President will probably include in his State of the Union Message to Congress. The Conference of State Governors which originally took a position in conflict with some views favored by the Clay Committee, has altered its previous tentative stand, so that there will be no major conflict with the Clay report. The net result is that the Clay Committee, to which the Governors' findings have been transmitted, will be able to submit a statement that will harmonize rather than intensify any seemingly vital differences of opinion. Since these reports may appear in the daily press before our publication date, no guesses will be hazarded as to their recommendations except to mention some areas that particularly concern the civil engineer.

How a sufficient number of engineers can be obtained to handle a program of the magnitude under consideration is an important problem. It has been intimated that the engineering societies have not been sufficiently aware of shortages in engineering personnel and have not taken adequate steps to correct them. Of course those who read of the activities of the EJC Manpower Commission already know, and others will soon have an opportunity to discover, how aware the profession has been of the situation and what exceptional steps have been taken to correct it. Obstacles created by government agencies and others have been overcome in part by the magnificent work of our Manpower Commission.

Another item of interest in the Clay report will relate to the place of toll roads in any expanded highway program. Their place may be restricted in a program which would cover the country with magnificent free boulevards, but when the hard realities of the situation are faced it is probable that they may find a place. The advocates of this phase of private enterprise will have to overcome the concerted opposition of powerful drives to eliminate toll roads from the program for the future.

Indications based on press releases and discussions are that the Clay Committee will recommend completion of the 40,000-mile interstate system largely at federal expense, with the states, perhaps, continuing to contribute their present share in dollars. Thus on a percentage basis this contribution would shrink greatly on an expanded program, from the 25 percent of the last highway bill passed to half that amount. A government lending agency to sell up to $25 billion in bonds has been widely discussed.

The Clay report will begin rather than end the discussion on roads. Able exponents will present a medley of views, and as usual Congressmen will consider what their particular constituents desire. References to this subject will appear in many future issues of CIVIL ENGINEERING.

Meetings and Conferences

The Field Representative recently had the opportunity of representing the Society at several meetings covering important fields of interest.

Under the immediate direction of the chief engineer of the Public Health Service, a group of fifteen interested societies discussed current and prospective programs in the field of water pollution, with particular reference to the operation of the Water Pollution Control Act. It was the consensus of the meeting that primary responsibility for pollution control should be in the states. Considerable difference of opinion was manifested concerning federal grants for construction of facilities. Streamlining of the enforcement procedure under the Act was favored. Increased research work was recommended. The group agreed that the federal government should provide adequately for disposal of wastes produced by federal installations or as a result of federal actions.

A conference called by the Secretary of Commerce to discuss the Department's interest in construction was attended by numerous trade association and professional society representatives. The construction forecast for 1955 will set a new record, perhaps 7 percent higher than the $37 billion record of 1954. Coordination between the Commerce and Labor Departments was announced to do away with necessary duplication of published statistics.

A conference on the modular system in building design was held in Washington to promote the use of the 4-in. module. The system is approved by AIA. Several prominent architects, builders and building materials manufacturers told of simplifying their operations and making savings in costs by the use of the system.

A conference on Plastics was held under the auspices of the Building Research Institute. The structural properties of plastics were discussed, for accessories such as awnings, skylights and glazed surfaces, and for pipes and conduits. Structural shapes and panels may serve a useful purpose in some cases. General satisfaction was expressed for the prospects of an enormous increase in the use of plastics in building, including pipes. Testing is being carried on to adopt plastics for use in construction where light weight, beauty and resistance to certain types of corrosion may indicate their use. Investigations of reinforced plastics for special uses are being made.

Washington, D.C.
December 19, 1954

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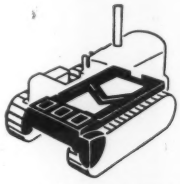
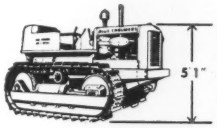
Here are reasons why more and more builders are choosing the popular Allis-Chalmers HD-5 Tractor for all kinds of dozing jobs—from land clearing to landscaping.



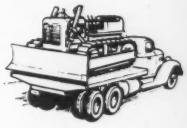
Built with Dozing in Mind The HD-5 is the only crawler in its weight and power class that is *new* in design and built with dozing in mind. The engine is not used as a structural member. Instead, weight and working stresses are carried by a full-length, all-steel welded main frame. This type of frame allows closer mounting of the blade, reduces front-end overhang for better balance, permits more direct down pressure on the blade, eliminates bulky track-straddling frame that often clogs up. The HD-5 is built to stand the gaff in clearing land, building streets — any heavy dozing.

Works Anywhere, Any Time Crawler design features large idler and sprockets, puts more track on the ground for better traction in soft, mucky ground — as in digging drainage ditches or filling in low, swampy areas. Plenty of weight, with low center of gravity, also helps assure good traction for all dozing.



Compact for Tight Places Only 5 ft, 1 in. high and less than 13 ft long, including blade, the HD-5 packs a lot of dozing punch (50 belt hp) in small space—works easily between houses, around poles and trees, any narrow quarters. Double reduction final drive allows ample 11¼-in. ground clearance.

Smooth Hydraulic Blade Control makes it easy for the operator to work all day without undue tiring effort, permits the accuracy needed for finish grade, working close to manholes, other objects. Full vision, simplified shifting, convenient controls, easy steering — all help the operator get the most work done with the least effort.



Quickly Hauled Job-to-Job by truck or small trailer, the HD-5 might be backfilling trenches on one job and a short time later be at another location several miles away excavating or cutting drainage ditches.

Maximum Work Time, Minimum Down Time Unit construction allows removal of major assemblies such as engine, clutch, transmission, steering clutches or final drive without disturbing adjacent assemblies, for big saving in down time — accessibility saves time for inspection, adjustment and servicing — exclusive 1,000-hour lubrication interval for truck wheels, idlers and support rollers cuts greasing time.

Write for literature giving more information — or let your Allis-Chalmers dealer show you how the HD-5B does outstanding work on all types of dozing. He will be glad to demonstrate right on your own job.

50 belt hp, 11,250 lb (bare tractor)

ALLIS-CHALMERS
TRACTOR DIVISION • MILWAUKEE 1, U. S. A.

NEWS BRIEFS . . .

Construction Seen as Setting New Record in 1955

New construction activity is expected to reach an all-time high of $39½ billion in 1955, 7 percent above the record-breaking $37 billion volume indicated for 1954, according to outlook estimates prepared jointly by the Building Materials and Construction Division of the Department of Commerce and the Labor Department's Bureau of Labor Statistics. The prospect for this increased volume in 1955 is based on the assumption that the general level of economic activity will remain relatively stable, and that the disposable income of consumers will continue at a record level. There should be sufficient capital funds available to finance a very large volume of construction at comparatively favorable rates, and it is assumed that construction costs will remain relatively stable.

Current indications are that both private and public construction will set new records, with private expenditures estimated to increase to $27.4 billion, and public outlays to $12.1 billion.

The greatest boost to privately financed construction, the joint agencies predict, will come from greater expenditures for new residential building (nonfarm), which is expected to increase by 13 percent to $15 billion and to account for 55 percent of all private construction. A continued strong demand for new homes, the ready availability of mortgage money, plus the easier credit terms provided by the 1954 housing legislation indicate that private dwelling units started in 1955 will exceed this year's anticipated high total by about 100,000 units. The total of 1,300,000 public and private housing units estimated to get under way next year would make 1955 second only to the peak year of 1950, when construction was started on 1,396,000 dwellings.

Important types of nonresidential building are also likely to break records. Current prospects are that commerical construction will continue to expand to a new high of $2.3 billion of work put in place in 1955, with the emphasis on new stores, shipping centers, and offices to service new housing developments and continued suburban growth. Religious and private educational building, which achieved more construction put in place in 1954 than in any previous year, will likely expand still more in 1955.

Public utility expansion as a whole will hold close to the peak levels of 1953 and 1954. Some decline in railroad and gas utility construction will be offset by moderate gains in petroleum pipeline construction and electric plant expansion. New industrial construction will probably be somewhat less than in 1954, declining moderately for the third successive year, since the major part of the huge defense plant expansion begun after 1950 has been put in place. However, the downturn in contracts awarded for industrial building has been leveling off so that the rate of decline in work put in place in 1955 is expected to be less than in 1954.

The anticipated increase in public construction activity next year reflects continued expansion for nearly all types of state and local public works. The value of expenditures on state and locally owned projects, for which a new high of $8 billion appears likely in 1954, will exceed the $9 billion level in 1955, the joint agencies forecast.

Highway construction is expected to reach a new high of $4.2 billion, nearly one-fifth above this year's level, reflecting the expanded program of federal aid to highways, and an anticipated increase in toll-facility construction. Public school building will continue its swift pace in 1955. Outlays to provide new public school facilities are expected to increase by 16 percent to $2.4 billion.

Public and private hospital construction is reported likely to increase in 1955, though it will not reach the levels attained in the 1949–1952 period. New sewer and water facility work in 1955 is expected to go over the $1 billion level for the first time. Outlays for direct federal construction, which experienced a substantial decline in 1954, will show a further but much smaller reduction in 1955. The principal decline will be for industrial building, particularly on atomic energy plants. Federal work on conservation and development projects will continue to decrease next year. On the other hand, construction work at military bases, following a 29 percent drop in 1954, is scheduled for a 20 percent rise in 1955.

High-Level Steel Bridge to Span Buffalo Ship Canal

Work on the new $12,000,000 high-level bridge across Buffalo Ship Canal is being pushed by the New York State Department of Public Works. Here two 208-ft, 169-ton suspended girders are being lifted from a barge, one at a time, and placed in position 120-ft above the water by two powerful derricks. The girders were fabricated at the Rankin, Pa., works of the Bethlehem Steel Co., the erection contractor, and shipped to the site in three sections. After the girders had been hoisted into position, they were connected at each end by a 13-in.-dia steel pin to a 70-ft cantilever arm protruding from the superstructure. They are set 40 ft apart, center to center. Skirting the Erie lakefront, the bridge will speed traffic between urban Buffalo and its southern suburbs and will also connect with the Niagara section of the Thruway. Plans, specifications and estimates for the bridge were prepared by the Lupfer Corp., and the Bates & Rogers Construction Corp. is the prime contractor for the superstructure.

Spectacular New Highway Opened to Traffic in Bolivia

Completion of an outstanding highway—the new 312-mile Cochabamba-Santa Cruz highway, which cuts through some of the wildest country in Bolivia—opens up a new life line for an isolated section of the country that is rich in vital raw materials. Trucks now travel between the two cities safely in fifteen hours—a trip that used to require anywhere from four days to a month. Viewed at the left is a portion of the highway hacked out of the Andes. This is in an area called the "rain forest," where the humid air from the Amazon Basin meets colder air, resulting in constant fog. The right-hand photo depicts the construction camp at Comarapa, Bolivia, for the army of workers on the project. As the result of an agreement between the Corporacion Boliviano de Fomento (the Bolivian government agency formed to carry out the project) and the U.S. Bureau of Public Roads, a United States engineer, Benjamin Cortrell, aided by Bolivians familiar with the topography, spent five years charting a route through the wilderness. Though the project cost $2,363,000, it proved so complete the final highway followed the route of the survey with only minor deviations. The New York engineering firm of Knappen, Tippetts, Abbett & McCarthy supervised construction, operation, purchasing and accounting, and the actual building contract was held by the Macco Panpacific Co. (now Thompson-Cornwall, Inc.). Photos through the courtesy of the Caterpillar Tractor Company.

Members on St. Lawrence Board of Consultants

A new Board of Consultants appointed by the St. Lawrence Seaway Development Corporation consists of four members—all of them members of ASCE. The appointees are C. E. Blee, chief engineer of the Tennessee Valley Authority, Knoxville; F. W. Edwards, manager of the Chicago office of the Stanley Engineering Co.; E. M. Fucik, executive vice-president of the Harza Engineering Co.; and C. M. Wellons, consulting engineer of Pittsburgh. Mr. Fucik is president and Mr. Edwards immediate past-president of the Illinois Section.

Ohio Opens First Section of Turnpike

The first 22 miles of the 241-mile Ohio Turnpike were opened to traffic on December 1 in ceremonies attended by the governors of Ohio and Pennsylvania and other state and turnpike officials. The section runs from the Pennsylvania border, where it connects with the Pennsylvania Turnpike, to a point west of Youngstown.

Speakers hailed the opening of the section as a historic occasion because it is the first actual joining of toll roads of major states, and the beginning of the eastern turnpike system that by 1957 will provide a limited-access, multiple-lane divided expressway between New York and Chicago.

The rest of the Ohio Turnpike to the Indiana border is scheduled for completion October 1, 1955. The cost of the 241-mile facility is estimated at $326,000,000. J. E. Greiner Co., of Baltimore, is the overall consulting engineering firm on the project.

California Has Large New Steam Power Plant

The largest steam power plant ever built west of the Mississippi—an outdoor-type unit with a capacity of 600,000 kw—was recently dedicated at Pittsburg, Calif., in the rapidly growing Suisun Bay area. The huge plant is the fifteenth steam electric facility operated by the Pacific Gas and Electric Company, which also has 57 hydroelectric generating plants. Two of its four turbine generators are now in operation, and the other two will be ready for operation this winter. Oil will be the primary fuel used, though the plant is designed for easy switching to natural gas operation when there is a surplus available. Walter Dreyer, M. ASCE, is vice-president and chief engineer of the P.G. & E. Co.

Contracts Let for Newark Bay Extension of Turnpike

Pushing construction work on its Newark Bay-Hudson County extension, the New Jersey Turnpike Authority recently awarded contracts totaling $6,264,529.80 to four low bidders. The largest of the contracts, for $2,086,684, went to the Reid Contracting Co., of Woodbridge, for paving, grading, and drainage in the area. The other awards include a contract for $1,672,660 to the Harris Structural Steel Co., of New York, to erect the steel superstructure of the viaduct in Newark; one for $1,589,505 to the Bethlehem Steel Co., of New York, to furnish and erect the superstructure at the Newark Airport interchange; and one for $915,680 to the Poirier & McLane Corp., of New York, to construct four bridges between the eastern end of the Newark Bay Bridge and the Avenue E interchange.

Work on the 6,500-ft bridge crossing of Newark Bay is progressing, and the entire 8.2-mile extension will be opened to traffic in the spring of 1956. The extension will provide direct access from downtown Manhattan and Hudson County to the turnpike and will also offer considerable saving in travel time between Newark, Bayonne, Jersey City, and downtown Manhattan.

Subcontracts Let for Hampton Roads Project

Award of two subcontracts in connection with the construction of the four-mile Hampton Roads tunnel-bridge project (December issue, page 89) is announced by Merritt-Chapman & Scott, the prime contractor.

The Baldwin-Lima-Hamilton Corp., of Philadelphia, received a subcontract for the fabrication of the 23 sections of double shelled steel casing that will be used in constructing the 6,860-ft underwater portion of the trench-type tunnel. The other subcontract went to the Atlantic Contracting Corp., of Norfolk, Va., for dredging and backfilling the trench for the precast tunnel tubes, dredging a relocated channel on the Hampton side, and building the two man-made islands that are planned for each end of the underwater section of the tunnel to link it with concrete approach bridges. The Atlantic Contracting Corp. is a joint-venture group made up of the Norfolk Dredging Co., of Norfolk, the Atlantic Gulf & Pacific Co., of New York City, and the Great Lakes Dredge & Dock Co., of Chicago.

Ford to Expand Dearborn Administration Building

Construction has started on a 156,000-sq ft addition to the Ford engineering staff administration building at Dearborn, Mich., the hub of the Ford Motor Company's vast research and engineering center and one of the oldest buildings in the area. The new extension, to be occupied late this year, will accommodate a number of key activities. It will be one story high and of brick construction in conformity with the older part of the building.

AISC Elects New Officers

Earle V. Grover, president of the Apex Steel Corp., Ltd., Los Angeles, was elected president of the American Institute of Steel Construction at the close of the organization's recent 32nd annual convention at White Sulphur Springs, W. Va. Other new officers elected were N. P. Hayes, M. ASCE, of Greensboro, N. C., first vice-president, and H. Buckley Dietrich, of Baltimore, Md., second vice-president. James M. Straub, of Pittsburgh, Pa., was reelected treasurer, and M. Harvey Smedley, of New York City, secretary. L. Abbett Post, who has been executive vice-president since 1947, was named again to this post.

Earle V. Grover

Dynamic Road-Testing Method Demonstrated

A machine for making non-destructive tests of the load-carrying capacities of asphaltic highways—developed over the past ten years by engineers in the laboratories of the Shell Oil Co. in Amsterdam—was demonstrated recently by the company. The demonstration took place at the U.S. Bureau of Public Roads' Langley Research Station in Virginia before a group of government and state highway engineers.

Essential to the method is a mobile machine, a two-wheeled trailer, on which are mounted eccentrically weighted fly wheels that transmit through four vertical columns vertical vibrations of controlled magnitude and amplitude to a base plate the size of a single tire resting on the pavement. The fly wheels are driven by a 2.5-kw direct-current variable-speed motor, for which current is supplied by a jeep-engine-driven generator mounted on the trailer. The forces applied to the pavement are of a magnitude and frequency simulating the effects of actual traffic.

Measurements of the effect of the loads applied by the machine are picked up and recorded by electronic instruments mounted in a light truck that accompanies the trailer. Deformation of the pavement is measured by a Phillips electro-magnetic pick-up of the seismographic type connected to a calibrated electrical system, which includes an oscilloscope and an electronic voltmeter in parallel circuits. The instrumentation system has a sensitivity of 1/25,000 of an inch of deflection in the pavement.

The relation between a load applied to a pavement and its sub-base by the machine and the resulting deflection are designated as the stiffness factor of the pavement. The values of this factor have been found to measure about 75 for a 2-in. asphaltic pavement laid on a 4-in. gravel base over a silty subsoil, and about 195 for a 4-in. asphaltic pavement laid on an 18-in. crushed stone base over clayey subsoil.

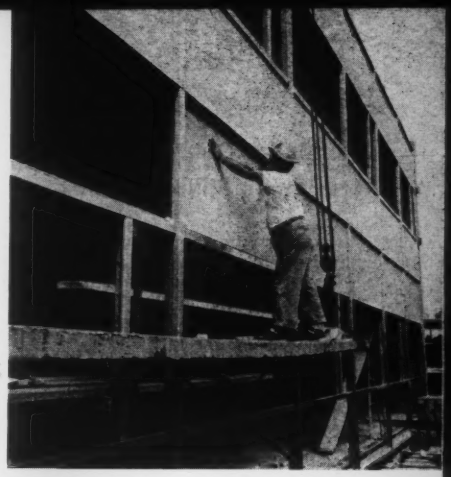
Other specific factors measured by the method are deformation in the top elements of the pavement and the velocities of the waves propagated by the vibration machine through the various layers of the pavement. From all these data fatigue characteristics of a pavement can be developed.

The instruments and the methods of their use, as developed by L. W. Nÿboer and C. Van der Poel, of the Shell Oil Company's Netherlands staff, are described in detail in the *Proceedings* of the Association of Asphalt Paving Technologists (Vol. 22, 1953). During the WASHO road tests just completed at Malad, Idaho, by the Highway Research Board, this equipment was used to make a series of measurements. It is expected that the results will be published with other data obtained during the conduct of the Malad test.

Since the properties of a completed road, as measured in tests by the method just described, appear to be closely related to the behavior of the road under traffic, this inexpensive test equipment promises to contribute to a better understanding of pavements and their load-carrying capacities. J. O. Izatt, A. M. ASCE, was in charge of the demonstration.

Mobile, non-destructive road-testing equipment, developed by Shell Oil Co. engineers, is shown in operation here. The base plate, which receives the impulses, may be seen on the pavement.

Insulated Porcelain Enamel Walls Feature RCA Victor Project



New techniques in the use of porcelain enamel panels for outer building walls are being applied on the Cherry Hill Project of the Radio Corporation of America now being completed at Cherry Hill, N.J. The project consists of five structures covering a total building area of 320,000 sq ft—the equivalent of an average 35-story building. When completed the 8- by 4-ft sandwich panels forming the major part of the front and rear wall areas are only $2^1/_2$ in. thick. The interior of the panels consists of a smooth metal skin, to which a 2-in. thickness of Foamglas cellular glass insulation is cemented. A small air space between the insulation and the exterior surface of corrugated porcelain-enameled steel protects the insulation from moisture by providing an outlet for condensation. The completed panel withstood a test simulating a rainstorm driven by a 100-mile gale without leakage or loss of rigidity. Foamglas is a product of the Pittsburgh Corning Corp. The general contractor, the Turner Construction Co., utilized the Lift-Slab method of construction on the project.

New Federal Highway Program Urged at AASHO Meeting

A new highway program with "the necessary capital expenditures substantially financed by the federal government" was asked by the American Association of State Highway Officials in a policy statement issued at its recent fortieth annual meeting in Seattle, Wash. More than 850 officials from all over the United States attended the conference, which heartily endorsed President Eisenhower's proposal for an enlarged highway program and offered its facilities for assembling any data and information that may be needed in formulating a program of action.

The AASHO policy statement also calls for continuance of federal funds for the federal-aid secondary, urban, and primary systems "in at least the same amounts as at present." In urging a new program in large degree financed by the federal government, the group suggested that the states assume the cost of maintenance, operation, and policing of the system, which should be "constructed to adequate standards as promulgated by the American Association of State Highway Officials." The statement goes on to urge adoption of such a program "so that the interstate system and its urban extensions may be completed within a period of ten years to further national defense and peacetime economy."

Methods and procedures used in contract maintenance were discussed in a session, at which the Subcommittee on Contract Maintenance presented its second progress report. In discussing contract vs. non-contract construction costs, the subcommittee expressed a majority opinion "that contracting costs are generally lower, expecially when they can be based on long-term data, that results are comparable or better, and that the contractors make a profit because they generally come back the next year in increasing numbers." Only when the last remark does not hold true, says the subcommittee, "should the state take note. Either the particular work does not appeal to contractors, or the department has failed either to maintain a fairly uniform (or an increasing) volume of work or to write a clear specification with clear units, satisfactory controls, and fair and intelligent inspection."

Of much interest was a paper on the economic evaluation of radio communication in highway maintenance by J.L. Stackhouse, A.M. ASCE, maintenance engineer for the Washington State Highway Department. Mr. Stackhouse gave the results of a recent special survey of the use of radio communication in the department. "Comparing the total number of radio units representing a complete exchange of communication per month with the monthly cost of providing radio communication facilities," he said, "we arrive at what is considered a conservative estimate of $1.90 per communication unit.

"For comparison purposes we have also calculated the average cost of all toll charges incurred by the department headquarters over a twelve-month period. This average is based upon the total toll charge divided by the total calls, which comes to $1.80 per call. It is to be noted that this figure does not include monthly rental charges on instruments.

"The consensus of opinion among maintenance engineers of the department attending a recent meeting held in Olympia," Mr. Stackhouse said, "was that to be deprived of the use of radio communication now would necessitate a 15 to 20 percent increase in men and equipment over the present number in order to perform the same work now being accomplished through their present ability to dispatch control crews and equipment by radio."

Among the other speakers were Robert H. Tittle, M. ASCE, engineer of construction for the Illinois Division of Highways; William P. Steuber, chief of public information for the Wisconsin State Highway Commission; Albert J. Hoskins, of the U.S. Coast and Geodetic Survey, Washington; and Francis V. du Pont, Special Assistant to the Secretary of Commerce and former Commissioner of Public Roads.

The AASHO will hold its forty-first annual meeting in New Orleans during the week of December 4, 1955.

Muskingum Electric Plant To Have Greater Capacity

Plans for further expansion of the American Gas and Electric Company System by the construction of a 225,000-kw steam-electric generating unit at the Muskingum River Plant of the Ohio Power Co., near Beverly, Ohio, are announced by Philip Sporn, M. ASCE, president of the AGE and its subsidiary, Ohio Power. Construction of the unit, which will cost about $29,600,000, is expected to start in January. Completion is scheduled for December 1956.

The addition to the Muskingum Plant will increase its generating capacity by more than 50 percent, raising it to 665,000 kw and making it the largest of the AGE's twelve major power plants. The first of its two present 215,000-kw units was placed in operation in December 1953, and the second last June. It is expected that the new unit will burn 570,000 tons of coal a year, raising the total annual requirement of the three-unit plant to 1,700,000 tons.

Kaiser Engineers to Make Nuclear Power Study

A proposal by the Kaiser Engineers Division of the Henry J. Kaiser Co., of Oakland, Calif., to study the feasibility of nuclear power reactors has been approved by the Atomic Power Commission, according to a recent announcement from the chairman of the AEC. In addition to determining the economic practicability of designing, constructing, and operating a power-producing reactor, the new study will include an examination of the technical problems involved in building such units. The eighteenth study authorized under the AEC's Industrial Participation Program, the present study will take a year and cost in the neighborhood of $100,000.

Aluminum Output in 1954 Near Three Billion Pounds

New records for the country's aluminum industry were set in 1954 as in the preceding year, according to a year-end statement prepared by the Aluminum Association. Both monthly and quarterly records were established in primary production, and the year's total, estimated on the basis of ten months' figures, will be approximately 2,900,000,000 lb, or 16 percent over the previous record set in 1953.

Except for one reduction plant which will go into operation early in 1955, the industry's so-called "second round" expansion is now complete. The Department of Defense abandoned its planned "third round" of expansion which would have increased the country's annual primary aluminum capacity by about 400,000,000 lb.

Production of primary aluminum at record levels naturally called for record tonnages of bauxite ore. There was a big increase in the amount of ore received from Jamaica as the two United States companies conducting operations there went into full production. Shipments from South America also increased substantially during the year, and one company began development of bauxite reserves in Haiti.

Contract for High Gorge Dam Given

Award of a $14,731,107 low-bid contract to the Merritt-Chapman & Scott Corp., of New York, and the Savin Construction Corp., of East Hartford, Conn., for construction of a municipal power dam on the Skagit River, Washington, is announced by the City of Seattle. Twenty-two major construction companies from all parts of the country took part in the bidding.

The project, to be known as High Gorge Dam, will be located near Newhalon, about 100 miles northeast of Seattle. It will increase by nearly 50 percent the present 108,000-kw capacity of a power plant now operated by the city about two miles from the dam site. Built of concrete, the dam will be about 670 ft long. It will run straight across the gorge, from the southern bank, for about 220 ft, cross the top of the pinnacle, and then swing on a curve to a point about 200 ft downstream on the northern bank. The dam will have a maximum height of 285 ft from the lowest point of excavation, and will rise about 140 ft above the tip of the pinnacle. The project is scheduled for completion in about four years.

New Cement Plant to Be Built at Gary, Ind.

Plans for construction of a new cement plant with an annual capacity of more than 3,000,000 barrels are announced by the Universal Atlas Cement Co., a subsidiary of U.S. Steel and a leading cement producer. The new plant, which will be the largest single production unit constructed in the cement industry in the past fifteen years, will be built adjacent to the company's Buffington plant at Gary, Ind. The combined Buffington plant facilities will have a total annual capacity of more than 10,000,000 barrels of cement.

The company also has plans for a clinker grinding plant and related facilities at Milwaukee, Wis., which will more than double the company's present bulk and package plant there. When the project is completed, cement clinker will be shipped by lake boats from Buffington to Milwaukee for grinding into finished cement on a year-round basis. This will eliminate barge shipments of cement that have been limited to about eight months of the year by winter shipping conditions on Lake Michigan.

Preliminary plans call for having both plants in operation by the end of 1956.

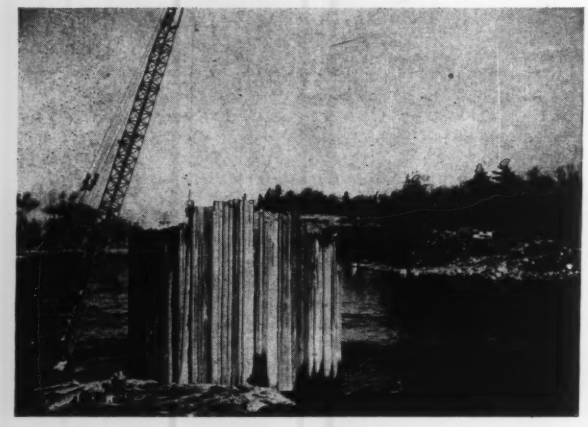
Construction Starts on St. Lawrence Project

Cofferdams are now being built for the Barnhart Power House and the Long Sault Dam, two major structures of the St. Lawrence Project, according to an announcement of construction schedules recently released by the Power Authority of the State of New York. Plans for both the power house and dam are nearing completion, with specifications to be ready for advertising soon. The Dravo Corp. has a contract for two of the cofferdams for the Long Sault Dam, and the Frederick Snare Corp. has a boring contract for the dam.

The dam will be a concrete-gravity structure with a maximum height of about 145 ft. It will have an overflow spillway flanked by concrete gravity bulkhead sections and earth wing dams and an earth dike. The 2,390-ft-long spillway crest will include twenty-nine 10-ft bridge piers.

The Barnhart Island Power Plant will be a reinforced concrete gravity structure with a maximum height of about 160 ft, base width of 184 ft, and overall length of 3,130 ft bisected by the International Boundary Line. It is of the fully outdoors type, housing sixteen units with erection bay, control room, offices, and miscellaneous shops enclosed in a brick, steel and concrete building over the shore ice sluices. In addition to the sixteen-unit blocks, the plant has three ice sluice blocks. The 1,000 × 550-ft switchyard of galvanized steel will be connected to the power plant by three concrete tunnels.

Uhl, Hall & Rich are consultants to the New York State Power Authority on the project.



One of the cofferdams under construction at the site of Long Sault Dam.

Government Research Reports Available

Members of engineering societies and similar groups are urged by the Department of Commerce to make more use of the growing stockpile of research reports released by the Federal Government through the Office of Technical Services. Some 350 such reports are described each month in *U.S. Government Research Reports* (formerly *Bibliography of Technical Reports*), which is available from the Government Printing Office, Washington 25, D.C., or any of the U.S. Department of Commerce field offices, at $6 a year.

This research, which is being conducted at a current rate of $2,000,000,000 a year, covers nearly every phase of industrial activity.

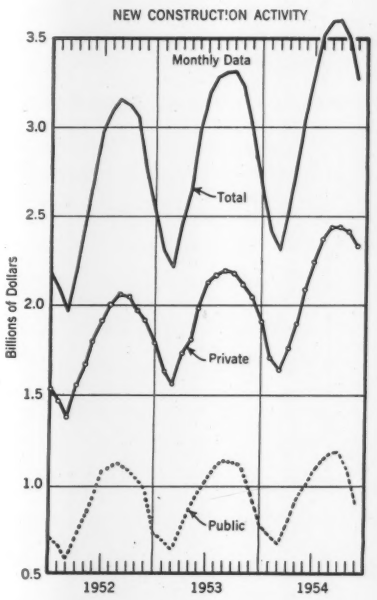
November Construction Activity Sets Record for Month

Although new construction activity declined seasonally in November, the $3.3 billion of work put in place set a new record for the month and was 8 percent above November a year ago, according to preliminary estimates prepared jointly by the U. S. Departments of Commerce and Labor. On a seasonally adjusted basis, outlays for new construction were at an annual rate of $38.1 billion, the highest level ever reached.

Expenditures for privately financed construction were at a new November high of $2.3 billion, with new home construction proceeding at an unprecedented rate for the time of year and nonresidential building volume matching the peak monthly activity achieved in the third quarter. Private residential building activity, at $1.3 billion, was the highest November total ever recorded, and nearly one-fourth more than similar outlays in the same month of last year. Expenditures for new office building and church construction were also at an all-time high, while continued recovery was indicated for private industrial construction which showed an upturn for the second consecutive month.

Total public outlays, at $0.9 billion, were about the same as in November 1953. All major classes of public construction declined seasonally, although the rate of decline was generally more moderate than the usual downturn from October to November. Strong late season activity was indicated for school building, highway construction, and sewer and water work, each of which registered a greater dollar volume of work put in place than in any previous November.

During the first eleven months of 1954, new construction outlays amounted to $34.1 billion, 5 percent more than in the same 1953 period. Total private work was up 7 percent over 1953 to $23.4 billion, with residential, commercial, religious, and educational building setting new records for the period. Continued increases in all important classes of state and local government construction have been virtually offset by a reduced volume of direct federal construction and public housing, so that total public construction expenditures through November 1954 were about the same as in the corresponding months of a year ago, $10.6 billion.



Despite usual seasonal decline, November construction expenditures were 8 percent above November 1953 setting a new record for the month, as shown here in Department of Commerce curves.

Modular Coordination Hailed at ASA Meeting

Modular coordination may well turn out to be the building industry's counterpart of the production line in industrial manufacturing, Harold D. Hauf, M. ASCE, head of the department of architecture at Rensselaer Polytechnic Institute, told members of the American Standards Association at the organization's thirty-sixth annual meeting held in New York in November. In accepting one of the organization's three awards for "achievement in the field of modular coordination," Mr. Hauf said that, "The dimensional coordination of materials and equipment coming to be known as modular measure can effect the economies of standardization without standardization of the building itself. It conserves productive resources by eliminating waste of materials by cutting and fitting on the job and consequently also eliminates the waste of labor effort." Others honored for their contributions to modular coordination were C. E. Silling, architect of Charleston, W. Va., and C. W. Kraft, president of the Kraftile Co., Niles, Calif.

Thomas D. Jolly, vice-president of the Aluminum Company of America, was awarded the Howard Coonley Medal for his contributions to the national economy by advancing voluntary standards. The Standards Medal was presented to John Gaillard, New York management counsel, who has contributed his "entire career to the practical development of standards." Previous recipients of the Howard Coonley Medal include Herbert Hoover, Hon. M. ASCE, William L. Batt, and Senator Ralph E. Flanders.

In the keynote address, ASA President Roger E. Gay warned that American businessmen may soon be unable to compete for international trade "because goods made in this country are useless for export unless they conform to the standards of the country buying them." He emphasized that unless U. S. industry makes a formal attempt to present the American side of the standards movement, we may find ourselves facing a situation where international agreements among closely allied countries would cause insurmountable barriers to the outward flow of our goods and services."

Mr. Gay will be succeeded as president by Edward T. Gushée, vice-president of the Detroit Edison Co. J. L. Cranwell, vice-president of the Pennsylvania Railroad, was elected vice-president.

Ernest Hartford Retires From ASME Staff

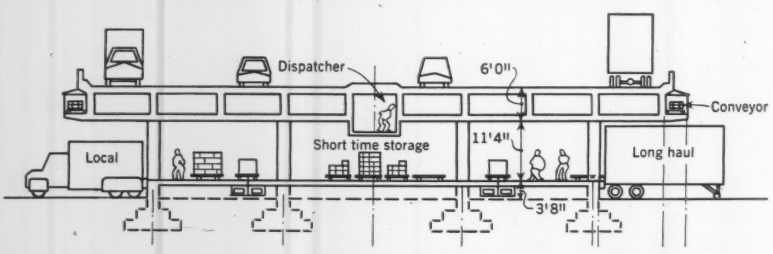
Ernest Hartford, of Yonkers, has retired as deputy secretary of the American Society of Mechanical Engineers after 43 years of service in the organization. He will continue to serve the ASME in a consulting capacity. During the war Mr. Hartford was granted a leave of absence to serve as office manager in charge of the executive offices of the Committee on Education for the War Department. His professional contributions include reorganizing and reactivating the Council of Engineering Societies Secretaries after the war. He is also credited with making a major contribution to the growth of the ASME, which had a tenfold increase in size during his tenure.

Contract Awarded for Army Package Reactor

The American Locomotive Company has been awarded a lump-sum contract to design, build, and test operate a proto-type "package" nuclear power plant of 2,000-kw capacity for military use (October issue, page 83). According to an announcement from the U. S. Atomic Energy Commission, the contract is the first of the kind to be let on a fixed-price basis and as such constitutes an important step in the development of power reactor technology. The contract price of $2,096,753 will be shared by the AEC and the Department of the Army. The design of the unit is based on studies by the Oak Ridge National Laboratory, which established the feasibility of developing such a plant for use at remote bases. The components will be transportable by air.

There were eighteen proposals submitted—twelve of them under $4,000,000.

Truck Terminal to Be Built Under Los Angeles Freeway



To meet the needs of the City of Los Angeles for a large close-in truck terminal and at the same time give it the economic advantage of keeping part of its Olympic Freeway on the tax rolls, the Los Angeles Community Redevelopment Agency is planning a truck terminal under the freeway. The proposed project, which will occupy a fifty-acre blighted area about two miles from downtown Los Angeles, is shown here in cross section. The superstructure of the eight-lane freeway will be the roof of the truck terminal dock. The freeway will have easements for columns and footings and air rights for the superstructure. Over the site of the truck terminal the freeway will necessarily be built on structure instead of on fill. The estimated cost of the combined project is $6,560,000. William T. Sesnon, Jr., is chairman of the CRA, the state law for which was adjudicated last year. William H. Claire, M. ASCE, assistant executive director of the Agency, originated the idea of the combined freeway and truck terminal.

N. G. Neare's * COLUMN

R. ROBINSON ROWE, M. ASCE

"This year will be different," announced Joe Kerr at the first meeting of the Engineers Club in 1955. "So different."

"A nice promise, if it means anything," mused the Professor.

"It really does, and I'm serious. You see, I finally passed the registration exam, so I have to be serious. It means that my New Year's resolution was to work every problem every month and let Cal Klater retire!"

"Fine! You can start by telling us how large are the San Diablo County potatoes grown in California and stored in atrophied culverts if the void ratio would be 50 percent greater for 27-in. than for 18-in. pipes."

"Well, not quite. My text on soil mechanics gives 26 percent as the voids ratio for spherical particles in an infinite mass. In a small container, the irregular voids around the boundary would increase, the ratio, but the increase should be greater for a small pipe than for a large pipe, and certainly not as much as 50 percent. Maybe I misunderstood the problem but anyway, it was last year's problem and I'm counting on easier ones this year."

"What an anticlimax to an empty bluff!" jeered Cal Klater. "Instead of a book, Joe should have compared the voids in a can of tennis balls to those in a bottle of colossal olives. If the olives were spherical with a diameter kd in a long bottle with diameter d, and so big that they formed a single staggered chain, then the solid ratio would be $\frac{2}{3}k^3/\sqrt{2k-1}$. If k was 0.625, as is common, the solid ratio is 125/384 and the void ratio 0.675. But for tennis balls just fitting the can, $k = 1$ and the voids ratio is 0.333, so it is possible to have one voids ratio even 100 percent greater than another.

"To solve the problem without running into big numbers, I let the diameter of each potato be $x = 54u$, so that $k = 3u$ for the 18-in. and $2u$ for the 27-in. pipe. The problem became:

$$1.50\left(1 - \frac{18u^3}{\sqrt{6u-1}}\right) = 1 - \frac{16u^3}{3\sqrt{4u-1}} \quad (1)$$

or

$$\frac{3}{2u^3} + \frac{16}{\sqrt{4u-1}} = \frac{81}{\sqrt{6u-1}} \quad (2)$$

which I solved by cut-try to find $u = 0.30137$, $x = 16.274$ in. Some potato, but I suppose Texas grows bigger ones!"

"So I've heard, but the Texas spuds are shaped more like peanuts than tennis balls," admitted Professor Neare. "Incidentally, Cal's equations can be rationalized into a quaterdecimic and solved by Horner's Method, making a nice exercise for gentlemen of leisure.

"Yielding to Joe's importunity, Guest Professor Stoop Nagle promises his new problem of the Quazy Quadrille will be easier than it looks even at second glance."

"I'll be kind to Joe," promised the Guest Professor. "At the beginning of this episode of the quadrille, the 4 couples had paused near 4 corners of the ballroom. Clockwise they were Art and Ann, Ben and Belle, Carl and Claire, and Dan and Dot. They followed directions as the caller chanted:

'Dames to the left, right for the gents,
Walk that line like it follers a fence;
Meet a partner half way, then both left face,
Step ahead just as far as you did on the base.'

"Art, who had been 27 ft from Carl was now 39 ft away and Belle was 15 ft from Dot. How far was Ben from Dan and Ann from Claire?"

[Cal Klaters who knew their taters were Stoop (John L.) Nagle (also the Guest Professor) and Thatchrite (Guy C. Thatcher), who also contributed a late solution to the October problem of the floating wedge.]

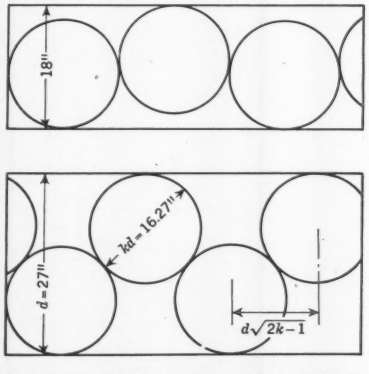
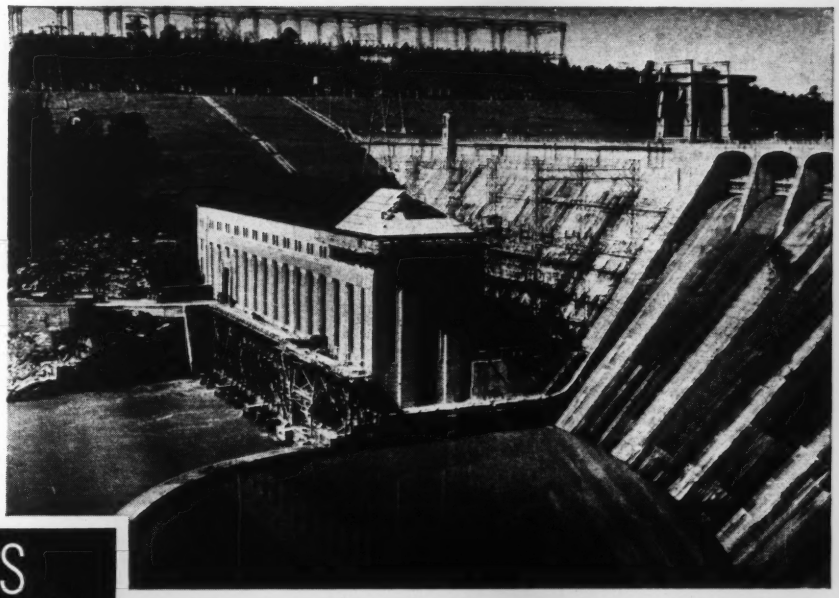


Fig. 1. For big potatoes, voids ratio is 50 percent greater in 27-in. than in 18-in. pipe.

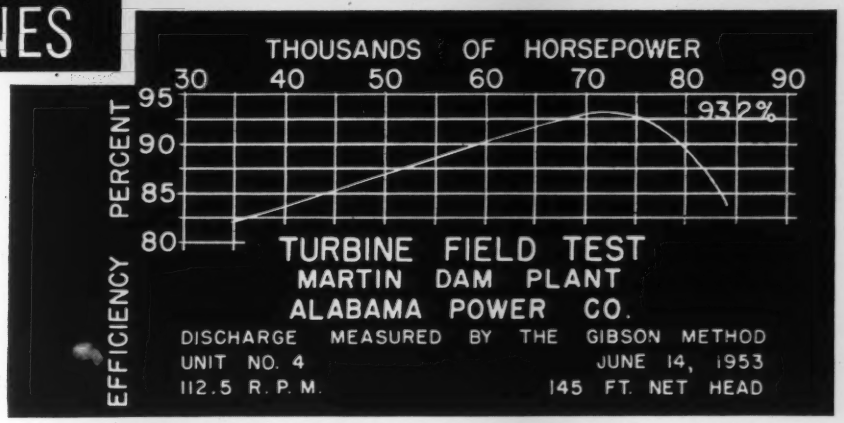
Heat Exchangers for Nuclear Power Plant

A contract to furnish two heat exchangers for the first full-scale nuclear power plant to be built in the United States has been given to the Babcock & Wilcox Co., according to C. H. Gay, vice-president in charge of the company's Atomic Energy Divison. The contract is with the Westinghouse Electric Corp., which has responsibility for the nuclear portion of the plant under an agreement with the Atomic Energy Commission. The Duquesne Light Co. will build the electric generating portion and will operate the power plant, which will be built on a site near Shippingport, Pa.

In keeping with the major aim of the project, which is to demonstrate the economic feasibility of nuclear power, the two heat exchangers feature a new design that involves less expensive materials and fewer complex shop operations than those used in any previous units.



SMS FRANCIS TURBINES



78,000 HORSEPOWER GUARANTEED in a 45,000 HORSEPOWER SETTING

At the Martin Dam on the Tallapoosa River, the Alabama Power Company was faced with the problem of getting the maximum output from the remaining space available. In spite of space and setting restrictions identical to those of the three existing 45,000 hp turbines, an SMS-Francis Turbine with 78,000 hp guaranteed capacity was installed.

A special new runner was developed by our Hydraulic Engineers specifically for the Martin Dam project. How well the conditions were met and requirements exceeded is demonstrated by the above performance obtained during the Official Acceptance Test.

You can call on over 75 years specialization in Hydrodynamics to help solve your problems. For full information on hydraulic turbines and accessories like valves and head gates, write to S. Morgan Smith Company, York, Pa.

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Rotovalves
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RECENT BOOKS

Seismicity of the Earth and Associated Phenomena

Evaluates the present relative seismicity of various parts of the earth, and discusses geographical and geological relations of the principal earthquake zones and areas. There are tables of earthquakes and earthquake activity, a list of active volcanoes, and a bibliography. In this revision, minor textual changes have been made, some new material has been supplied as addenda, and most of the tables have been extended chronologically. The authors are B. Gutenberg and C. F. Richter. (Princeton University Press, Princeton, N.J., 1954. 310 pp., $10.00.)

Strength and Resistance of Metals

Essentially an enlargement of Part II of *Applied Elasticity* by Timoshenko and the present author, John M. Lessells, this volume for advanced students and engineers centers on the behavior of steel under stress, but considers also non-ferrous alloys and cast iron in cases where their behavior differs from steel. Individual chapters treat tension, overstrain, tensile properties at high temperatures, mechanical wear, etc., and three chapters are devoted to fatigue and fatigue failures. Bibliographical footnotes are included. (John Wiley & Sons, Inc., 440 Fourth Ave., New York 16, N.Y., 1954. 450 pp., $10.00.)

Water Conditioning for Industry

Fundamentals of processes, typical installations, and operating techniques of a wide range of water conditioning methods are described by Sheppard T. Powell, the author. These include coagulation, filtration, softening, demineralization, deaeration, and others. Allied subjects such as steam contamination correction, corrosion of metals, electrolytic corrosion control, boiler scales, etc. are also discussed. Although the emphasis is on preparation of water for high-pressure boilers, processes covered are widely applicable. (McGraw-Hill Book Co., Inc., 330 West 42nd St., New York 36, N.Y., 1954. 548 pp., $9.00.)

ASTM Standards on Cement

Thirty-four test methods, specifications and definitions for natural, portland, and masonry cements are brought together for convenient use in this compilation. Appendixes include a manual for testing, a selected bibliography, and an article on the methoxyl method for determining vinsol resin in portland cement. (American Society for Testing Materials, 1916 Race St., Philadelphia 3, Pa., 1954. 247 pp., $2.75.)

Géologie des Barrages et des Amenagements Hydrauliques

This treatise by M. Gignoux and R. Barbier on the geology of dams and their hydraulic systems covers topographic and geologic conditions, earth movements, diversion tunnels, exploratory boring for dam and tunnel location, consolidation of permeable strata, and an extensive treatment of reservoir problems. The illustrations have English translations of the captions and descriptive information. (Masson et Cie, Paris, 1955. 343 pp.)

Welding for Engineers

This textbook, by Harry Udin, Edward R. Funk and John Wulff, based on a course given to juniors at the Massachusetts Institute of Technology, emphasizes principles and adopts, wherever possible, the analytical rather than the empirical approach. All the important unit processes are covered, with the amount of material devoted to a given process dependent on its industrial importance. (John Wiley & Sons, Inc., 440 Fourth Avenue, New York 16, N. Y., 1954. 430 pp., $7.50.)

The Use of Stereographic Projection in Structural Geology

A simple, brief account of the subject, by F. C. Phillips, designed for the working geologist with no previous knowledge of the method. Principles are outlined and shown in application to the solution of various kinds of specific structural problems—determining true and apparent dip, interpreting cores from non-parallel bore holes, etc. The last chapter illustrates the usefulness of the method in synthetic studies of the tectonics of a region. There is an appendix on calculation by spherical trigonometry and a bibliography. [Edward Arnold Ltd., London (available in U. S. from St. Martin's Press, Inc., 103 Park Avenue, New York 17, N. Y.) 1954. 86 pp., $3.00.]

ASTM Standards on Bituminous Materials for Highway Construction, Waterproofing, and Roofing

Test methods, specifications, definitions of terms, and recommended practices relating to the field are compiled in a single volume for convenient use. New material in this edition includes test methods for asphalt insulating siding surfaced with mineral granules; staining properties of asphalts; Saybolt Furol viscosity of asphaltic materials at high temperatures; and specifications for bituminous saturated woven burlap fabrics. Twenty-five of the standards in the previous edition have been revised. (American Society for Testing Materials, 1916 Race St., Philadelphia 3, Pa., 1954. 434 pp., $4.00.)

Bibliography of Rivers and Harbors and Related Fields in Hydraulic Engineering

Contains over 6,000 references to English and foreign books, reports, documents, etc., classified by selected subject headings, arranged alphabetically by Robert S. Rowe under each heading, and indexed by authors and subjects. In addition to sections on rivers and harbors, there are sections covering hydraulic engineering in general, inland canals and waterways, interoceanic canals, reclamation, flood dams and reservoirs, water power, and water supply engineering. Although periodical articles are not included, journals in the field are listed under appropriate headings. (Rivers and Harbors Section, Dept. of Civil Engineering, Princeton University, Princeton, N.J., 1953. 407 pp., $10.00.)

Manual on Industrial Water

Special Technical Publication, No. 148-A

The general discussion of uses of water, problems of supply, composition, sampling, and analysis, and related subjects is essentially a reprint of the 1953 edition. Material newly incorporated consists of eleven new test methods, a number of revisions of existing methods, a complete table of contents, and a detailed subject index. Several new proposed methods are also included. (American Society for Testing Materials, 1916 Race Street, Philadelphia 3, Pa., second printing, 1954. 420 pp., $5.00.)

City Planning at Yale

These papers, edited by Christopher Tunnard and John N. Pearce, are condensed versions of lectures given to students, or of reports prepared by the latter as a part of their studies. They deal with various aspects of city planning: civic design, location of industry in relation to towns, achieving a balanced region, etc. One of the papers is a proposal, given in considerable detail, for planned development of the St. Lawrence Seaway region. (The Graduate Program in City Planning, Dept. of Architecture, Yale University, New Haven, Conn., 1954. 86 pp., $1.50.)

Contributions to the Solution of Systems of Linear Equations and the Determination of Eigenvalues

Applied Mathematics Series, No. 39

Contains seven papers, edited by Olga Taunsky, dealing mainly with various aspects of the solution of simultaneous equations, including practical methods with worked examples, a study of iterative procedures, manual computation methods, experiments with punched cards equipment, and high speed computations. Two of the papers deal with the rank of a matrix and location of its eigenvalues. (National Bureau of Standards: Available from Superintendent of Documents, Government Printing Office, Washington 25, D. C., 1954. 139 pp., $2.00.)

Mechanical Refresher for Professional Engineers License

Another in the well-known series of reference manuals by John D. Constance compiled to aid license candidates in preparing for examinations. It offers a summary of essential theory and numerous problems in the fields covered in Part Three of the New York State Professional Engineering Examination, comparable to Junior and Senior examinations in other states. (625 Hudson Terrace, Cliffside Park, N. J., first edition, 1954. Various pagings, $3.00.)

Nickel in Iron and Steel

Alloys of Iron Research Monograph Series

This monograph by A. M. Hall supplies in a single volume essential information previously scattered in books and journals in many languages. The occurrence and refining of nickel ores is reviewed and there is discussion of melting and working of nickel alloy steels; physical properties; principles and practices of the metallography and heat treatment of wrought nickel steels; and the effect of nickel on engineering properties. Cast irons containing nickel are similarly covered, and there are chapters on corrosion, welding, and fabricating. A bibliography of 784 references is provided. (Published for the Engineering Foundation by John Wiley & Sons, Inc., 440 Fourth Avenue, New York 16, N.Y., 1954. 595 pp., $10.00.)

Strength of Materials

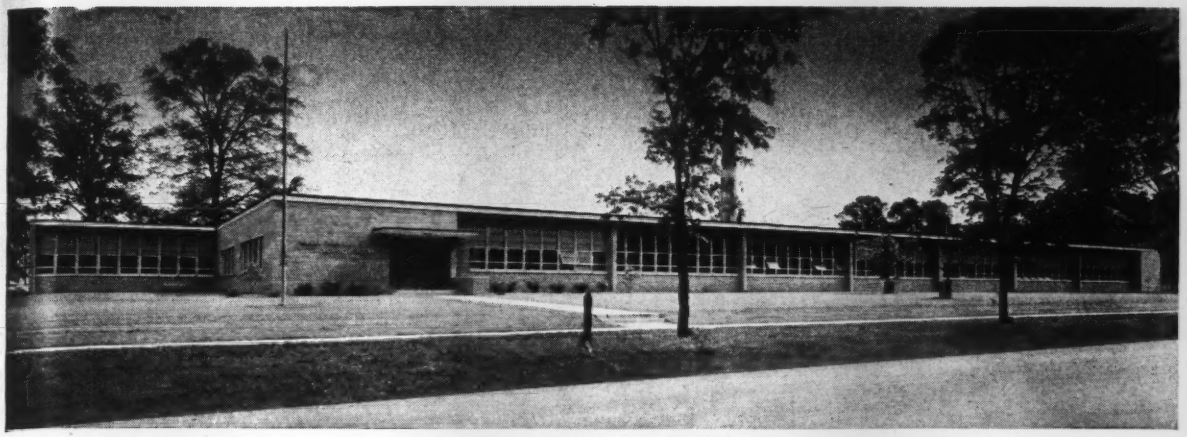
Revisions in this edition of a standard British text, by Arthur Morley, for engineering students include the reworking of material on fatigue, creep, criteria of elastic strength, and metallurgical developments of ferrous metals. The last three chapters of the previous editions, covering properties and testing of materials, have been omitted. (Longmans, Green and Company, 55 Fifth Avenue, New York 3, N.Y., eleventh edition, 1954. 532 pp., $4.50.)

Time-Saver Standards

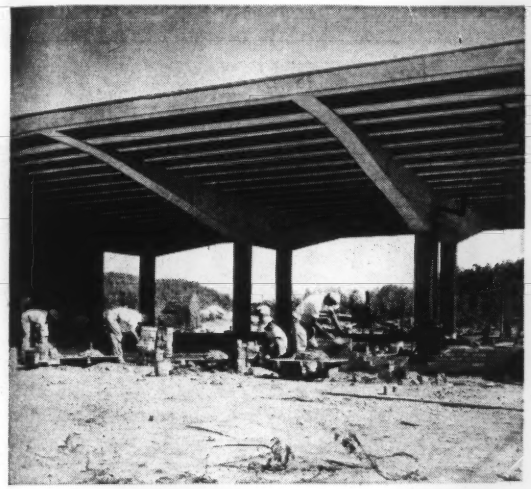
An Architectural Record Book

Essential information for architectural drafting, designing, and specification writing is presented in this manual in condensed, graphic style. The six sections provide readily usable information on office practice, structural design, residential and non-residential design elements, site planning, landscaping, and building materials and equipment. Some of the material in the previous edition has been eliminated and more than a hundred pages have been added. (F. W. Dodge Corporation, 119 West 40th Street, New York, N. Y., third edition, 1954. 888 pp., $12.50)

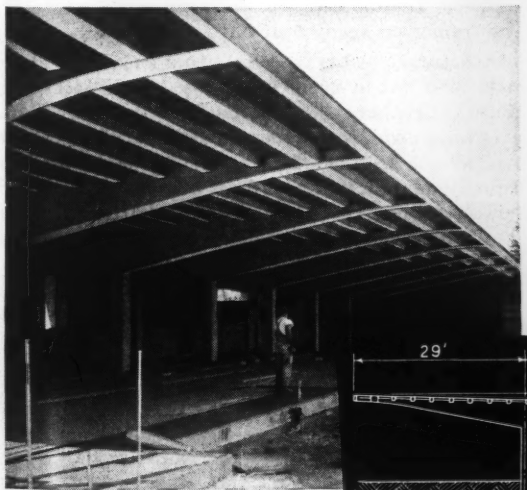
[*Editor's Note:* In the "Recent Books" section of the December issue, Volume III of Elwyn E. Seelye's *Data Book for Civil Engineers* (John Wiley and Sons, Inc., New York) is erroneously priced at $17.50. The correct price is $7.50.]



Merle Sidener School, Indianapolis. Architects: Daggett, Naegele & Daggett; engineers: Fink & Roberts; contractor: Cannon Construction Co.



Above: The all-concrete roof covers two rows of outside classrooms and a central corridor. With its overhang, the roof is 68 ft. wide. Below: 29-ft. concrete cantilever beams extend from corridor columns over the classrooms and exterior walls.



Right: cantilever beams extend across auditorium from opposite walls, meet at center. Floor here is lowered 4 ft.

Concrete and Cantilever Design Cut Costs for Modern School

Attractive, modern appearance distinguishes this fine school, completed at a cost of only 92¢ per cu. ft.—20 to 25 per cent less than the cost of other new buildings of comparable size and quality in the area.

Concrete cantilever beams at 17′ 2″ centers are an outstanding feature in the design. Supported on twin concrete columns that form a central corridor, they extend beyond the exterior walls of the classrooms as roof overhang. Concrete ribs between the cantilever beams carry lightweight precast concrete panels that form the roof.

In the auditorium, cantilever beams from opposite walls join at the center of the room to form a 58-ft. roof span (see drawing below). Exposed concrete masonry, used for partitions and backup throughout the structure, assures maximum firesafety, economy and durability.

Concrete construction for schools is moderate in first cost, means lower maintenance expense and extra long life. These factors add up to ***low annual cost***—which pleases school officials and taxpayers alike.

Write for free booklet on concrete school design and construction, distributed only in the U. S. and Canada.

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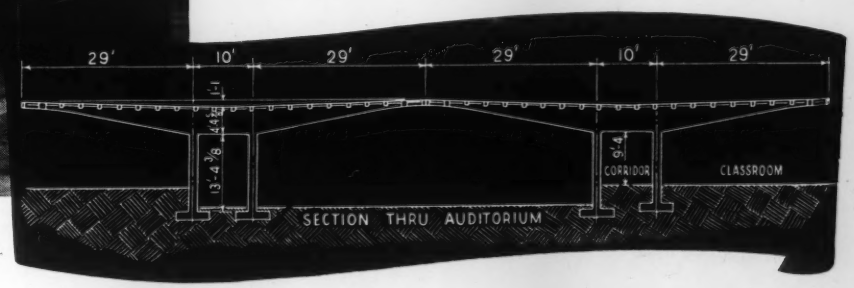
A national organization to improve and extend the uses of portland cement and concrete . . . through scientific research and engineering field work



"Hurry-up construction"

at lowest cost calls for USS Structural Ste

The company: **Minneapolis-Honeywell Regulator Co., Los Angeles.**

The problem: **Not enough space (frequently heard nowadays). Another building needed in a hurry.**

The answer: **A new, expandable machine shop with plenty of natural light, a shop that's economical and easy to maintain.**

● The structural design chosen consisted of a series of 30′ x 60′ bays, the roof framing of which was composed of tapered-steel girders and open-web joists. Using this economical design coupled with the use of USS Structural Steel, the builders were able to obtain 30′ x 60′ bays at very little more than 20′ x 40′ bays would have cost had some other design or material been used. Among others considered, but eliminated due to prohibitive cost, were welded north-light rigid-frame gable bents, 60′ steel trusses, precast-concrete bents, and prestressed concrete beams.

U.S. Steel's Consolidated-Western Division of Los A geles contracted to have the steel frame ready for insta tion of walls and roofs within 43 working days after rec of approved blueprints. This included making shop de drawings, shop fabrication, painting and erecting the st The frame was ready four days ahead of schedule.

Structural Steel is the most economical of load-carry materials. Yet, it is the strongest. It will withstand m abuse than other structural materials—effectively resist tension, torsion, compression and shear. Enclosed in bui ings, it will last indefinitely—requiring no maintenan Equally adaptable to riveting, welding, or bolting, Str tural Steel can be erected in any weather in which m can work. And since steel members are fabricated indoo weather can have no effect on the quality of workmansh

For further information on construction with steel, wr to the United States Steel Corporation, 525 William Pe Place, Room 4591, Pittsburgh 30, Pa.

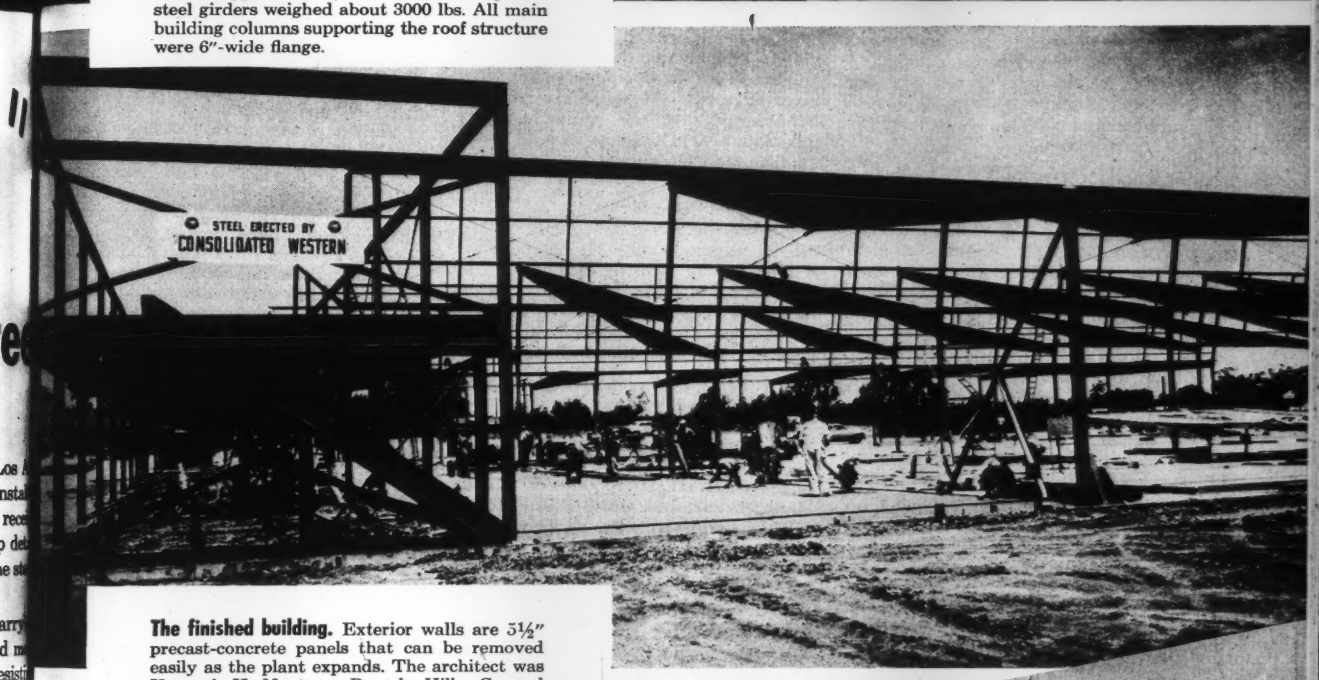
UNITED STATES STEEL CORPORATION, PITTSBURGH • COLUMBIA-GENEVA STEEL DIVISION, SAN FRANCISCO
TENNESSEE COAL & IRON DIVISION, FAIRFIELD, ALA. • UNITED STATES STEEL SUPPLY DIVISION, WAREHOUSE DISTRIBUTORS
UNITED STATES STEEL EXPORT COMPANY, NEW YORK

USS STRUCTURAL STEEL

USS

UNITED STATES STEEL

The Structural Steel framework during erection. The principal tapered-steel girders are approximately 60′ long, measuring about 42″ at mid-span, and having heel heights at the ends of approximately 16″. The main tapered-steel girders weighed about 3000 lbs. All main building columns supporting the roof structure were 6″-wide flange.



The finished building. Exterior walls are 5½″ precast-concrete panels that can be removed easily as the plant expands. The architect was Kenneth H. Neptune, Beverly Hills; General Contractor was Wohl-Calhoun, Los Angeles; and Structural Engineer was Richard R. Bradshaw, Los Angeles.

DECEASED

Ural S. Armstrong (A.M. '46), age 58, land surveyor and project engineer with the New Mexico State Highway Department at Santa Fe, died on March 25, 1954. Before and after World War I Mr. Armstrong was engaged in private practice. In 1931 he joined the Highway Department as concrete inspector and assistant project engineer, and in 1935 became project engineer in charge of highway construction.

John P. Badenhausen (M. '09), age 78, founder and retired president of John Phillips Badenhausen, Inc. of Philadelphia, died on August 21. Mr. Badenhausen received an M.E. from Stevens Institute of Technology and an M.E.E. from Cornell University. At the start of his career he was connected with various steamship companies and was first secretary of the Pacific Engine Co. and later president of the Elliott Bay Iron Works. Later he was employed by Day & Zimmermann and in 1946 founded the firm of Badenhausen Wyncote.

Clifford A. Bechtold (J.M. '50), age 28, since 1951, inventory engineer with the Great Lakes Pipeline Co. of Sioux Falls, S. Dak., died on July 20. After receiving his bachelor's degree in engineering from Marquette University in 1950, Mr. Bechtold was employed by the Scott Engineering Co. as consulting engineer.

William Greenfield Corlett (M. '24), age 67, of the architectural firm of Corlett and Anderson in Oakland, Calif., died on October 27. A graduate of the University of California, Mr. Corlett worked for various architectural offices and in 1912 joined the firm of Walter D. Reed. He became partner in 1916. Later he was associated with Corlett and Anderson.

Clarence Williamson Butts (M. '26), age 78, long connected with the Tennessee State Highway Department at Nashville, died on June 28, 1954. During the first half of his career Mr. Butts worked for various railroads as designer and construction engineer. With the Highway Department since 1919, he became special engineer in 1926, and from 1931 to 1938 was assistant state highway engineer. During the war he was safety director for the War Department at the Nashville Municipal Airport. In 1949 he returned to the Highway Department as traffic engineer.

Charles Percy Cathers, Jr. (M. '42), age 56, structural engineer for Wilson & Co., Engineers of Wichita, Kans., died on October 23. After graduating from the Univerfity of Kansas in 1924, Mr. Cathers was employed by the Missouri Pacific Railroad Co. becoming field engineer in 1926. Later he was assistant county engineer for Montgomery County, Kans., and in 1938 opened a consulting and designing practice. During the war he was supervising engineer for the Defense Plant Corp., Little Rock, Ark. Later he joined the Process Engineering Co. of Dallas, Tex.

James Calvin Foss (M. '23), age 69, of Santa Cruz, Calif., died on June 13. A graduate of Leland Stanford, Jr. University, Mr. Foss was in Hawaii with numerous water, irrigation and railway companies from 1908 to 1913. After three years of private practice he joined the Spreckles Sugar Co. and then the Hetch Hetchy Water Supply, City & County of San Francisco. In the thirties he was with the City & County of San Francisco as hydraulic engineer and later founded and was president of the James C. Foss, Co.

Edward James Fucik (M. '19), age 74, consulting engineer of Highland Park, Evanston, Ill., died on September 8. A graduate of the University of Illinois, Mr. Fucik devoted his entire career to design and construction of river and harbor works on the Great Lakes. From 1908 to 1926 he was with the Great Lakes Dredge & Dock Company of Chicago. From then until he retired in 1943, he was vice-president and director of the Fitz Simons & Connell Dredge & Dock Company of Chicago.

John Henry Glander (A.M. '14), age 71, consulting engineer of Birmingham, Ala., died on September 8. Mr. Glander was employed from 1905 to 1923 by Charles W. Leavitt, of New York City, as assistant engineer. From then until his death he practiced consulting civil and landscape engineering in Birmingham.

Clifton Ewing Hickok (M. '18), age 73, retired engineer of Berkeley, Calif., and former president of the California City Managers Association and vice-president of the International Association of City Managers, died on October 9. A graduate of the Universities of Oregon and California, Mr. Hickok was city engineer and then city manager of Alameda, Calif. Later he was chief engineer, assistant state director, and assistant state engineer in California for the PWA. In 1943 he became senior public works engineer for the National Resources Planning Board at Berkeley and from 1949 until he retired in 1951 was principal administrative analyst for the San Francisco FHA.

Alfred E. Hirsch (M. '52), age 62, chief of the planning and reports branch of the Baltimore District Office, Corps of Engineers, died on October 15. After Mr. Hirsch graduated from the Technische Hochschule of Vienna he was assistant engineer for the St. Louis-San Francisco Railway Co. During twenty-one years with the Corps of Engineers, Mr. Hirsch worked on pile dike and revetment construction on the Missouri River and utility installations for Quoddy Village in Maine. Since 1942 he had been in the Baltimore District Office.

Alfred E. Hirsch

James Henry Hood (M. '39), age 72, retired vice-president and director of Stone and Webster Engineering Corp. of Boston, died this October. Mr. Hood, a graduate of Tufts College, was associated with Stone & Webster from 1905 when he started work as a field engineer until his retirement as vice-president in 1948.

Edward Henry Howard (M. '10), age 78, consulting engineer of Framingham, Mass., died on October 21. Graduating from Worcester Polytechnic Institute in 1900, Mr. Howard started work in 1902 for the B. & W. Street Railway Co. as assistant and chief engineer. In 1913 he opened a private practice. Mr. Howard was an investigator for land courts, chairman of planning boards, and real estate appraiser for various banks.

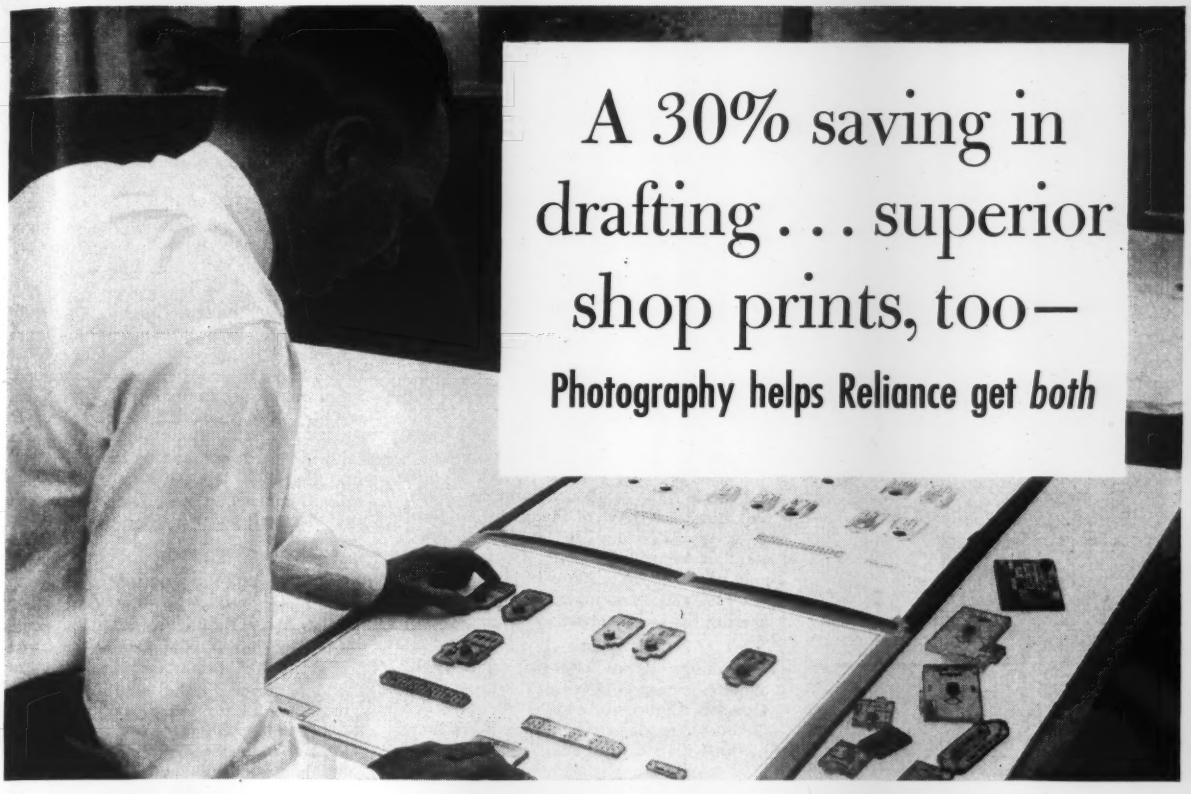
Edgar William Hussey (A.M. '37), age 50, district manager of the Soule Steel Co., Portland, Oreg., died on August 21. Mr. Hussey was designer with the Morris Dam Project, Pasadena, Calif., after he graduated from the University of California. In 1934 he started work for the San Francisco branch of the Soule Steel Co., and in 1936 transferred to the Portland branch where he remained until his death.

Carl Joseph Jacobsen (A.M. '19), age 68, president of Carl J. Jacobsen, Inc., Pittsburgh, Pa., died on October 31. Mr. Jacobsen worked for various branches of the Farris Bridge Co. from the time of his graduation from the University of Wisconsin in 1912 until he left there as vice-president in 1941. He then started his own firm.

Seymour H. Knight (M. '20), age 78, since 1927 supervising engineer of Strawbridge & Clothier, Philadelphia, died on October 18. Mr. Knight's early career was spent with various railroad companies until, in 1918 he joined Day & Zimmermann, of Philadelphia, as civil and advising engineer. In 1924 he became supervising engineer for the Chicago River Bridge Survey, and in 1926 he returned to Philadelphia as supervising engineer for the Sesqui-Centennial Exposition. The following year he joined the Philadelphia store.

Paul Byron Lee (M. '46), age 54, former chief, Pavements and Railroads Branch, Engineer Section, Headquarters Sixth Army, Presidio of San Francisco Calif., died on October 1. Mr. Lee was principal engineer at Luke Air Force Base, Ariz., during the early part of the war. From 1922 until the war he was with the Missouri Department of Highways at Joplin—for a number of years as district engineer of maintenance.

(*Continued on page 92*)



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(*Continued from page 90*)

Clarence Moriarty (M. '24), age 66, since 1950 project manager of Smith, Brown & Root at Anchorage, Alaska, died on October 14. For ten years following his graduation from Iowa State College in 1912, Mr. Moriarty had a private practice in Sioux City. He was then employed by the U.S. Fidelity & Guaranty Co. as district engineer. Shortly before the outbreak of the war he came to Alaska to direct the engineering of airports and highways in the Territorial defense program for various construction firms.

Charles Michael Morssen (A.M. '07), age 82, of Montreal, Canada, died on May 8, 1954. A graduate of Ecole National des Ponts et Chaussées of Paris, Mr. Morssen worked for five years in Poland, coming to Montreal as engineer and superintendent of Heumelrique Construction Co., Ltd. He later became president of Atlas Construction Co. and chairman of the board. Later he had a private practice and then joined Concrete Engineering Ltd. as construction engineer.

Jennings Bryan Oldham (A.M. '26), age 57, vice-president of the Lone Star Cement Company of Dallas, died on October 5. Mr. Oldham was a graduate of the University of Texas, class of 1921. His association with Lone Star Cement began in 1921.

John Carleton Phillips (A.M. '11), age 83, retired associate engineer in the U.S. Engineer Department at Fort Worden, Wash., died on October 3. Mr. Phillips' long association with the Department began in 1899 at Forts Worden and Casey. In 1906 he was in charge of constructing the fortifications at Subic Bay in the Philippines before returning to work at Fort Worden. At the time of his retirement, in the early thirties, he was associate engineer.

Edward Richard Polley (M. '33), age 59, vice-president of Fairchild Aerial Surveys, Inc., Los Angles, Calif., died on August 15. Mr. Polley was a graduate of Rensselaer Polytechnic Institute, class of 1920. He was general manager of Fairchild's New York office prior to becoming vice-president in 1931.

John Hart Porter (M. '26), age 64, consulting engineer of St. Louis, Mo., died on February 5, 1954. A graduate of the University of Georgia, Mr. Porter was commissioner of the Missouri Public Service Commission from 1926 to 1933. Until the war, when he was on the staff of the Army Corps of Engineers for the Upper Missippi Valley Division, he had a private practice in St. Louis. After the war, he again organized a consulting firm, Elliott & Porter. In 1950 he started work on a report project for the City of St. Louis and the U.S. Bureau of Public Roads.

John Waller Pritchett (M. '46), age 71, consulting engineer of Austin, Tex., died on April 19. A graduate of the University of Texas, Mr. Pritchett for a long time was engineer for the Texas State Board of Water Engineers. In 1936 he became connected with the Board.

Elmore Marcellus Rohrbough (M. '18), age 93, since 1911 president of Rohrbough Engineering Co. of Omaha, Nebr., died on May 9. Before starting his company, Mr. Rohrbough worked for many Western railroad and irrigation companies as chief engineer.

Frederick LeVerne Serviss (M. '48), age 59, professor of geology at Purdue University, died on July 22. Professor Serviss graduated from the Colorado School of Mines in 1920 and received his master's degree in 1922. He had been employed by various companies as a mining engineer and geologist when, in 1929, he joined the Purdue faculty as assistant professor. In 1935 he became professor of economic and engineering geology.

Edward Beniah Snell (A.M. '12), age 75, of Elsmere, N.Y., died on October 27. Mr. Snell graduated from Massachusetts State College in 1903. He started work for the War Department in the New London office of the Army Corps of Engineers and later was transferred to the New York office where he was promoted to senior engineer in 1929. In 1935 he became principal engineer and in the war held the position of area engineer in Albany.

Frederick Antes Snyder (M. '15), age 82, noted subway and tunnel engineer of East Orange, N.J., died on October 19. Mr. Snyder was engineer in charge of the construction of the Holland Tunnel from 1921 to 1928 and worked on the rock tunnel for the Grand Central project in New York and the Midtown Hudson River Tunnel. In more recent years he had been safety engineer for the New York City Board of Water Supply.

Earl Frederick Speh (M. '32), age 66, retired engineer of Escalon, Calif., died on October 2. In 1915 Mr. Speh joined the Tela Railroad Co. (United Fruit Co.) in Honduras as chief draftsman and office engineer. After work for other firms, he returned in 1925 as chief engineer and superintendent of railways. In the thirties he started a ranching business.

James Ernest Stewart (M. '28), age 69, hydraulic engineer for the West Penn Electric Company of Pittsburgh, died on October 24. Mr. Stewart was a graduate of Iowa State College. In 1912 he started work with the Water Resources Branch of the U.S. Geological Survey, remaining there until 1923 when he became hydrographer for the West Virginia Power & Transmission Co. In 1929 he began his long association with the West Penn Electric Co.

Earle Everett Teeter (M. '25), age 72, retired engineer of Monticello, Ind., died

(*Continued on page 96*)

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More training for engineers

(This article begins on page 57)

fields. Employers of civil engineers can do much to alleviate this situation by hiring and training undergraduates for subprofessional work during summer vacation periods. Direct contact with practical engineering not only helps in the over-all training of the young man but it also stimulates and crystallizes his interest in his chosen profession at an earlier age. Incidentally, it places the company's name before students and makes recruiting at graduation easier.

Some young engineers are located geographically so that they can participate in night courses through a university extension service. Occasionally, short courses lasting a few weeks at the most are offered by a nearby college. Various industrial and governmental organizations encourage their employees to take advantage of such opportunities. In some cases, a nominal amount of absence with pay is permitted.

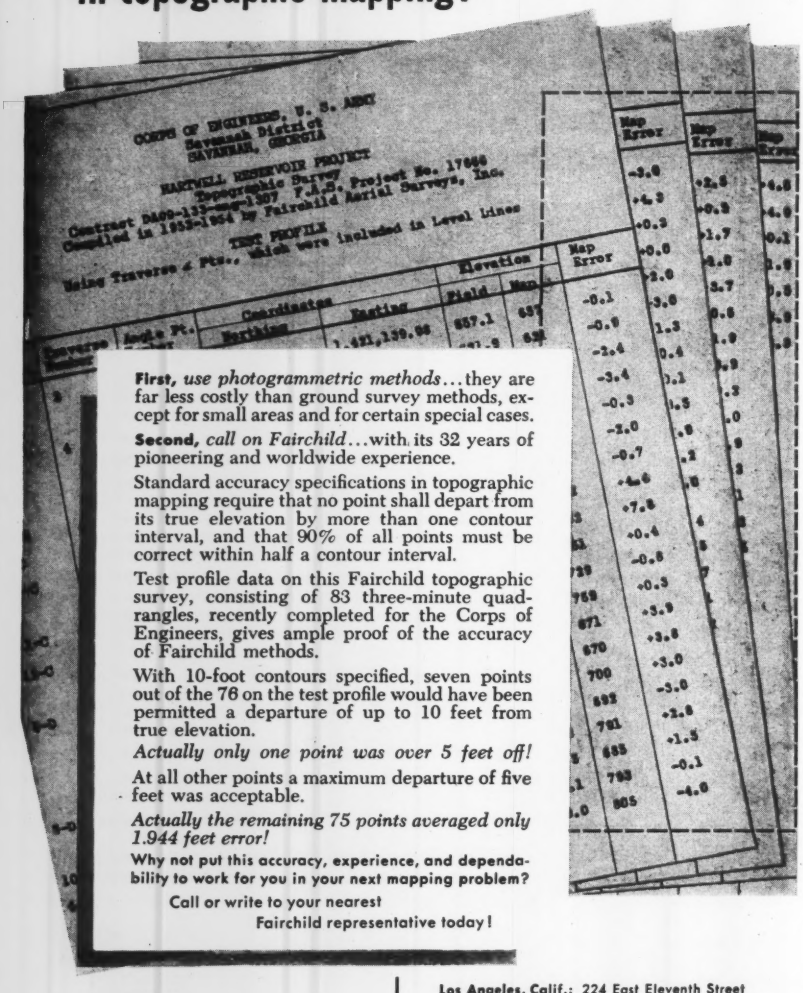
Formal attendance at an institution offering graduate programs is another possibility. It is evident that this possibility is becoming less attractive because of high starting salaries after the B.S. degree and the increasing cost of graduate studies. Civil engineers and employers of civil engineers can alleviate this situation in several ways. Some can set up graduate scholarships or fellowships at institutions of their choice. Those who cannot do this can contribute to established funds. They can also be alert to opportunities for establishing scholarships or otherwise giving students financial assistance at their places of business or in their engineering alumni groups. It is obviously desirable to work closely with the dean of engineering at the chosen institution particularly if the organization is to enter the picture.

If an organization does not wish to establish an outright scholarship, it still may be interested in sponsoring a research program which will give a graduate student some financial support while adding materially to his training. At the same time, it may benefit the sponsoring group. One company has recently made it possible for a well-known university to offer two fellowships for research in the field of materials for bituminous paving mixtures. Another is sponsoring a study of the movement of moisture through soil. Similar projects are widespread in other fields of engineering. It should be pointed out that an individual who is interested in helping young men obtain more graduate training will usually find that management has a similar interest. Frequently, the seed need only be planted in the right place. A clear-cut proposal to an executive in the organization often needs very little selling.

Your committee on Engineering Education is concerned also with the development of exceptional men for research and teaching and suggests that additional means be found for assisting such men to obtain their Doctorates. Advanced training is needed for future teaching and research, and financial help in this area is of primary importance. National Science Foundation grants are one possibility that should not be overlooked. This also means that civil engineers must work with the sister societies to encourage continuance of these grants by congressional appropriation. Individual engineers and teachers must be on the alert for suitable prospects and encourage young civil engineers to apply for any grant that will assist them financially.

In general, the present status of civil engineering in the scholarship and fellowship field is evident from an examination of the lists of such awards at any college or university. It will be found, with few exceptions, that both undergraduate and graduate civil engineering students have fewer possibilities of financial assistance from such awards than do those majoring in other branches of the profession. This situation should not be allowed to continue.

How to get *more than your money's worth* in topographic mapping!



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Test profile data on this Fairchild topographic survey, consisting of 83 three-minute quadrangles, recently completed for the Corps of Engineers, gives ample proof of the accuracy of Fairchild methods.

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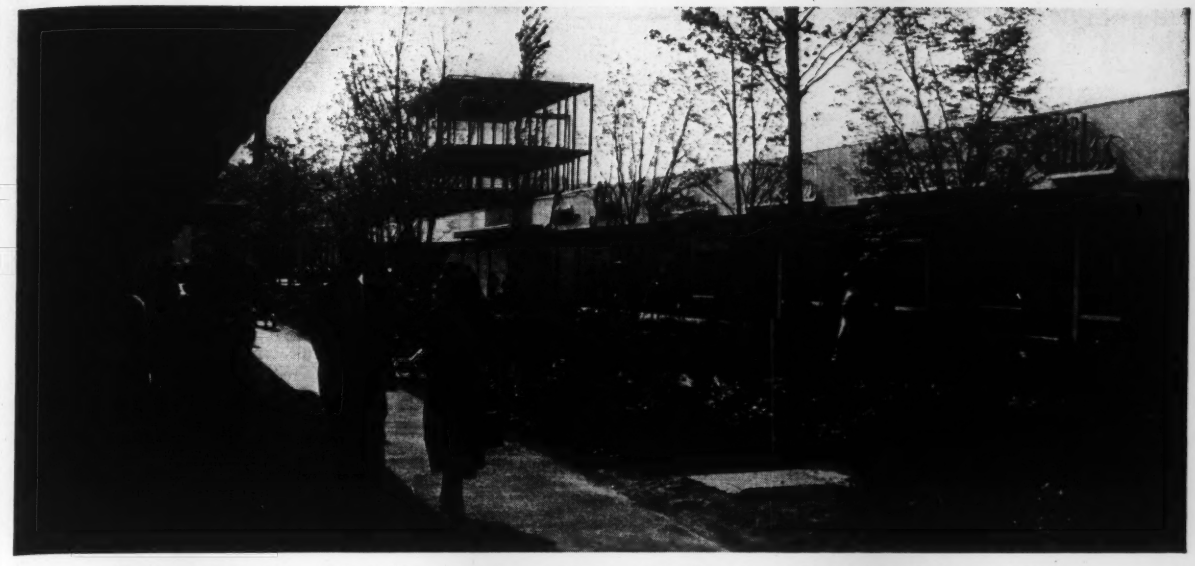

The pleasantly shaded mall, flanked by modern shops, adds charm to the Cross County Center's basically functional design. Towering in the background is the 1500-ton Bethlehem steel framework of the new Gimbel Brothers branch department store.

ANOTHER SUBURBAN SHOPPING CENTER TAKES SHAPE

One of the more spectacular indications of the current movement of population away from congested cities has been the phenomenal growth of suburban shopping centers. An estimated 2000 such developments, large and small, are now in the planning or construction stages, or have been recently completed.

Among the largest is the $30,000,000 Cross County Center at Yonkers, N. Y., at the southern tip of prosperous Westchester County. This 70-acre project, developed by Sol G. Atlas and designed by Lathrop Douglass, boasts branches of two famous department stores—John Wanamaker and Gimbel Brothers. These and other features are expected to attract shoppers from the Bronx and upper Manhattan, as well as from the surrounding suburban areas.

Many of the Center's stores are situated on the 1000-ft-long landscaped mall. At either end of the mall stand the department stores, Wanamaker's to the east, Gimbel's to the west. Ultra-modern in every respect, the stores are constructed on steel frames totalling over 3000 tons, fabricated and erected by Bethlehem.

Among the varied features of the mammoth project are two banks, a 125-bed hospital, restaurants, an auditorium, a huge supermarket and parking fields accommodating 5140 cars.

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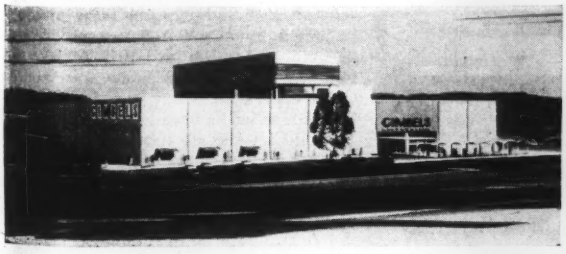
BETHLEHEM STEEL

BETHLEHEM STEEL

Architect's drawing of the Gimbel Brothers branch department store. The two-story-and-basement, 250,000-sq-ft building will be ready for business in Spring of 1955.



Planning a grand opening in late Fall of '54, Wanamaker's will provide "split-level" parking, with lots at various levels for stair-free access to all three shopping floors.

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(*Continued from page 92*)

on October 24. After his graduation from Purdue University in 1907, Mr. Teeter started work with the U.S. Reclamation Service. Promoted to assistant engineer in 1915, he worked for the next seven years on the Rio Grande Project and later was with the Bureau of Reclamation in other states. Before the war he became engineer for the Federal Power Commission in Washington, D.C.

Horace Richmond Thayer (M. '15), age 81, retired associate professor of mechanical engineering at Fenn College, Cleveland, Ohio, died on September 25. A graduate of Massachusetts Institute of Technology and Lehigh University and writer of engineering books, Mr. Thayer taught engineering at Carnegie Institute from his graduation until 1920. Later he taught at the International Correspondence Schools, Columbia University and (from 1928 until 1942) Pennsylvania State College. He then became associate professor at Fenn College.

Watson Walker (M. '48), age 66, assistant engineer with the Georgia State Highway Department, Macon, Ga., died on August 6. A 1917 graduate of the University of Georgia, Mr. Walker began his career as engineer and inspector for the City of Savannah. From 1919 to 1925 he was assistant county engineer for Bibb County at Macon, and then was city engineer of Macon.

Francis Potts Witmer (M. '09), age 81, prominent author and educator of Philadelphia, Pa., died on October 27. For three years Mr. Witmer taught at the University of Pennsylvania, from which he graduated in 1893 returning in 1924 as director of the civil engineering department. In the interim he worked for the American Bridge Co. and had a private practice. In 1943 he joined the Philadelphia firm, H. A. Kuljian, as structural engineer.

Francis P. Witmer

William Gordon Woolfolk (M. '16), age 76, since 1940 president of United Light & Power Co., Michigan Consolidated Gas Co. of Detroit, died on April 20. During the early part of his career Mr. Woolfolk worked for various railway and light companies. In 1912 he joined Sanderson & Porter, of Chicago, becoming manager in 1917. Later he founded and was president of William G. Woolfolk & Co., Inc. in Chicago. In the thirties he became president of the Detroit City Gas Co.

Herbert W. Yeo (A.M. '10), age 77, of Las Cruces, N. Mex., died on October 2. A graduate of Franklin College, Mr.

Yeo was with the U.S. Bureau of Reclamation for a number of years. In 1927 he was state engineer of New Mexico and later worked for the International Water Commission in Texas. He also was assistant agricultural engineer for the Soil Erosion Service of New Mexico and, until he retired, was associate agricultural engineer for the Soil Conservation Service at Albuquerque, N. Mex.

Positions Announced

The Government of Guam. The government has need of a responsible planner (Engineer IV) to be head of the Planning Division of the Department of Land Management. The position entails responsibility for the master plan, land use, layout of public buildings, providing all administrative work for the Territorial Planning Commission, making recommendations on subdivisions and planning all streets. The position paying $5,980 plus a territorial post differential of 25 percent, totals $7,475 a year. Full transportation and housing (at reasonable rates) are provided by the government. Applicants must have civil engineering, architectural, or city planning training and experience in the planning field. Applications should be sent to Charles M. Earl, Jr., Acting Director of Personnel, Government of Guam, Agna, Guam.

U.S. Civil Service Commission. Applicants with the appropriate education or experience are needed for filling map and chart making positions in various federal agencies in the Washington, D.C. area. The positions and yearly salary are as follows: Cartographer, $3,410–$10,800; Cartographic Aid, $2,750–$4,205; Cartographic Technician, $4,620–$5,940; and Cartographic Draftsman, $2,750–$4,205. There will be no written test. Complete details are contained in civil service announcement No. 375 and additional information may be obtained from the U.S. Civil Service Commission, Washington 25, D.C. Applications must be filed with the Commission's Washington office.

Veterans Administration Central Office. A number of vacancies in the Central Office in Washington for engineers in connection with the Veterans Administration hospital program are open. They include GS-7, Structural Engineer, requiring an engineering degree or 6 months of professional experience (beginning at $4,205 and up); GS-9, Civil (Sanitary) Engineer, requiring a C.E. degree or 1½ years of experience with at least one year of difficult and important work in the engineering branch for which application is made (beginning at $5,060 a year). For further information write Central Office Personnel Service, Veterans Administration, Washington 25, D.C.

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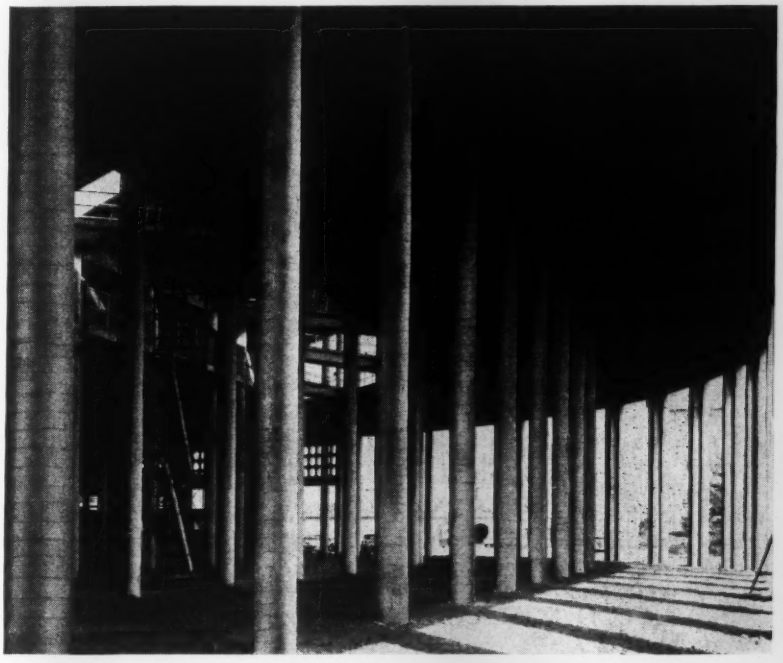

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Non-ASCE Meetings

American Concrete Institute. Fifty-first Annual Convention at the Hotel Schroeder, Milwaukee, Wis., February 21–24. For further details contact R. E. Wilde, American Concrete Institute, 18263 W. McNichols Rd., Detroit 19, Mich.

American Concrete Pipe Association. Forty-seventh Annual Convention at the Sheraton-Plaza Hotel, Boston, March 9–12.

American Congress on Surveying and Mapping and the American Society of Photogrammetry. Annual Meeting at the Hotel Shoreham, Washington, D.C., March 7–11.

American Society of Heating and Ventilating Engineers. Sixty-first Annual Meeting at the Bellevue-Stratford Hotel, Philadelphia, January 24–28.

American Society for Testing Materials. Committee Week and Spring Meeting at the Netherland Plaza Hotel, Cincinnati, Ohio, January 31–February 4.

Associated Equipment Distributors. Thirty-sixth Annual Meeting at the Conrad Hilton Hotel, Chicago, January 23–27.

California Street & Highway Conference. Seventh Conference sponsored by the Institute of Transportation and Traffic Engineering, at the University of California, Berkeley, February 2–4.

College-Industry Conference. Sponsored by the Relation with Industry Division of the American Society for Engineering Education in collaboration with the Iowa Engineering Society, Des Moines, Iowa, March 1–2.

Concrete Conference. Fifth Annual Conference sponsored by the School of Civil Engineering, Oklahoma Institute of Technology, American Concrete Institute, Portland Cement Association and the concrete industry, at Oklahoma A & M College, Stillwater, January 19–21.

Eastern Snow Conference. Twelfth Annual Meeting at the Vermont Hotel, Burlington, Vt., February 10–11. For further information write Dean B. Bogart, Secretary, P.O. Box 948, Albany 1, N.Y.

Engineers Joint Council. All-day General Assembly at the Hotel Statler, New York, January 21, beginning 9:30 a.m., evening banquet. Free tickets for the day's meeting from EJC, 29 West 39th Street, New York 18, N.Y.

High-Speed Computers. 1955 Conference at Louisiana State University, Baton Rouge, La., February 14–16.

Highway Engineering Conference. Twenty-eighth Annual Conference sponsored by the University of Colorado, Boulder, February 24–25.

National Association of Corrosion Engineers. Eleventh Annual Conference and Exhibit at the Palmer House, Chicago, March 7–11. Corrosion Short Course at the University of Tennessee, Knoxville, March 1–4.

National Society of Professional Engineers. Annual Spring Meeting at the Hotel Charlotte, Charlotte, N.C., February 18–19.

Plant Maintenance & Engineering Show. International Amphitheater, Chicago, January 24–27. Registration tickets may be obtained from Clapp & Poliak, 341 Madison Ave., New York 17, N.Y.

Society of American Military Engineers. Midwest Conference to discuss national defense at Conrad Hilton Hotel, Chicago, February 10–11.

Society of Automotive Engineers. Annual Meeting and Engineering Display at the Sheraton-Cadillac Hotel, Hotel Statler and Detroit Masonic Temple, Detroit, January 10–14.

Society of Plastics Engineers, Inc. Eleventh Annual Technical Conference at Haddon Hall Hotel, Atlantic City, N.J., January 19–21.

University of Illinois. Forty-first Illinois Annual Conference at Urbana, March 1–3.

U.S. Chamber of Commerce. National Conference on Highway Financing to discuss methods of financing the President's Highway Program, Washington, D.C., January 13–14.

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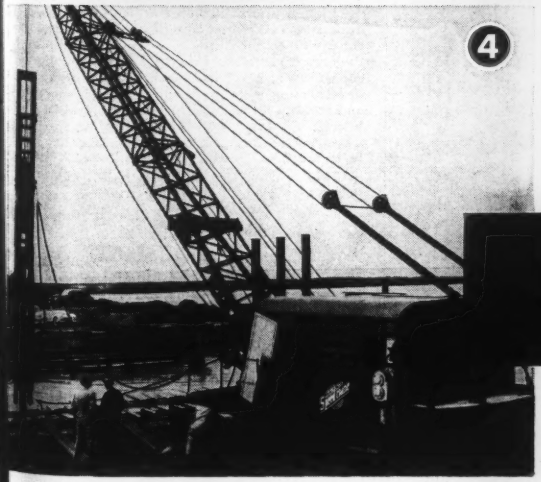

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THE list of Monotube advantages is long. And you are welcome to *all* the facts . . . anytime. Meanwhile, think of the time and money you can save as a result of . . .

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In general these products are specially designed for structures which control or contain water. Preformed joint fillers used in conjunction with rubber waterstop fill and seal expansion or construction joints so effectively that considerable hydrostatic pressure on one surface of the structure is not allowed to come through the joint.

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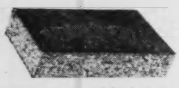

CORK Premolded Joint Filler has a high recovery factor (95%) after compression — is non-extruding and inconspicuous in mass concrete structures. Keeps the joint filled at all times.

SELF-EXPANDING CORK is specially treated to expand to 150% of original thickness to insure positive joint filling where concrete shrinkage problems are present. Non-extruding . . . and resilient.

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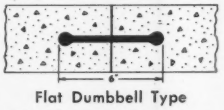
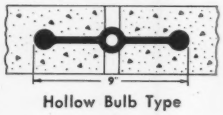
Servicised Waterstop is flexible and elastic, with a very high tensile strength — easy to install and once in place withstands contraction, expansion and shearing movement to insure a positive permanent watertight seal against hydrostatic water pressure.

Two types — Flat Dumbbell and Hollow Bulb. Both types meet all standard engineering specifications. Waterstop also available in fabricated ell's and tee's.



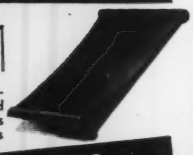
Flat Dumbbell Type



Hollow Bulb Type

NEW! SPLIT DUMBBELL TYPE

Servicised Split Type Waterstop spread open and nailed to inside of bulkhead. This eliminates slotting — saves time and labor.



Saves time, labor — eliminates split bulkheading. One half of waterstop width is split to permit fastening to bulkhead to form a "T" (see illustration). After pour, bulkhead is stripped, and divided section joined by stapling or with rubber cement. Also lower cost field splicing using Servicised Union.

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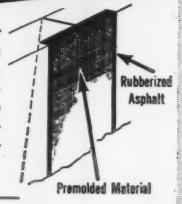

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New Publications

Building Code. Construction standards for one- and two-family dwellings and multiple dwellings are set forth by the New York State Building Code Commission in a second edition of its *Code Manual*. The expanded (308-page) manual gives more coverage to fire-resistance ratings for structural elements and assemblies, and detailed tables on maximum allowable spans of rafters, and of floor and ceiling joists. Free copies are available to enforcement officers where the state code is applicable; the price to other is $3. Requests for copies should be sent to the State Building Code Commission, 1740 Broadway, New York 19, N.Y.

Review for Surveyors. A revision of his famous compilation of review questions for surveyors is announced by Prof. Russell C. Brinker, M. ASCE, head of the civil engineering department at Virginia Polytechnic Institute. In the present (fourth) edition, entitled *2222 Review Questions for Surveyors*, there are questions of all types—multiple choice, completion, discussion, true and false, and problems—the result of twenty years of collecting. Intended as a supplement to text and field books, the 176-page illustrated publication is equally useful as a review for examinations. A ring binding facilitates its use. The volume may be ordered directly from Professor Brinker, Box 153, Blacksburg, Va. The price is $3 for a single copy, and $2.50 a copy on orders of five or more copies.

Hydraulic Research. Private, university, and government supported hydraulic research projects in the United States are listed and briefly described in a recent Department of Commerce publication entitled *Hydraulic Research in the United States, 1954*. Copies are for sale by the Superintendent of Documents, Government Printing Office, Washington 25, D.C., at a $1.25 each.

Bibliography on Building. A compilation of information on building construction and maintenance makes up National Bureau of Standards *Building Materials and Structures Report 140* by L.D.C. Nobel. The 35-page listing includes both free and sale publications available from government, trade association, and universities, a few pertinent ASA and ASTM standards, and some government specifications. The bibliography is for sale for 30 cents by the Government Printing Office, Washington 25, D.C.

Wave Research. In *Planning Residential Subdivisions*, V. Joseph Kostka stresses the multidisciplined approach necessary for the successful design of residential subdivisions. Written for the civic administrator, the planning consultant, the civil engineer, and the student, the publication coordinates the four aspects of site design and development—planning, engineering, landscaping, and architecture—in such a way as to be of mutual benefit to each type of practicing specialist. Copies are obtainable from the School of Architecture at the University of Manitoba, Winnipeg, Canada. The price is $3.50, with payment by postal money order requested.

Aluminum Alloys. The new alloy designation system developed by the Aluminum Association for wrought aluminum and aluminum alloy products is described in a brief pamphlet made available by the Association. Inquiries should be sent to the Aluminum Association, 420 Lexington Avenue, New York 17, N.Y.

Gravity Waves. Tables basic to nearly all design problems connected with the gravity waves

(*Continued on page 102*)

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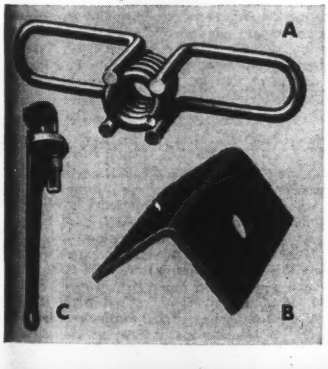

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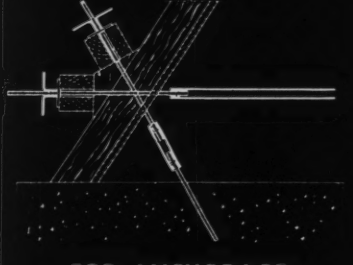

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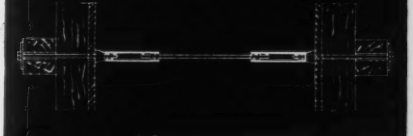

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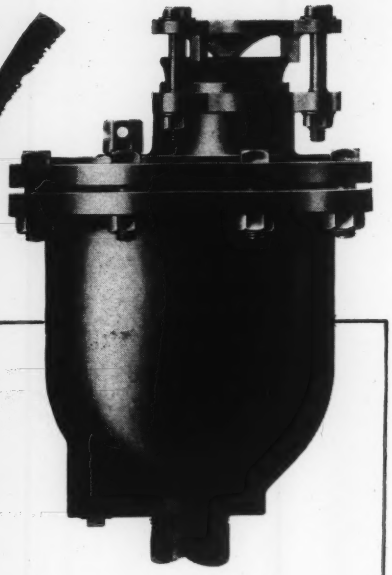

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New Publications

(*Continued from page 100*)

of oceans, lakes, reservoirs, and harbors have been made available by the Council on Wave Research of the Engineering Foundation. The author, Robert L. Wiegel, computed the tables while working on a contract between the University of California and the U.S. Navy Bureau of Ships. Entitled *Gravity Waves Tables of Functions*, the publication may be ordered from the Council on Wave Research 244 Hesse Hall, University of California, Berkeley 4, Calif. The price is $1.

Engineering Seismology. Publication of a bibliography of engineering seismology is announced by the Earthquake Research Institute. The 150-page book contains about 1,000 selected entries pertinent to the engineering aspects of earthquakes and earthquake-resistant construction. Copies at $3.50 may be obtained from R. W. Clough, Secretary E.E.R.I., Division of Civil Engineering, University of California, Berkeley, Calif.

Structural Engineering. Investigations of the elastic stability of the top chord of a three-span continuous pony-truss bridge conducted at the Iowa Engineering Experiment Station have been issued as the Station's Bulletin 177. The authors are Frank L. Kerekes, M. ASCE, and Cornie L. Hulsbos, J. M. ASCE, professor and associate professor of civil engineering at Iowa State College. Free copies are available upon request to the Director of the Iowa Engineering Experiment Station, Ames, Iowa.

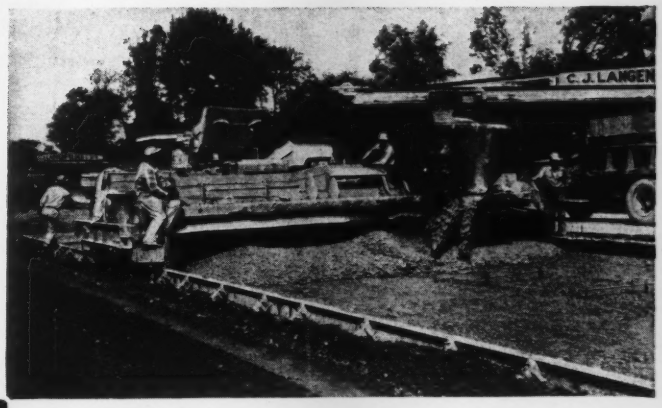
Corrosion. Summaries of 3,512 articles, books, and brochures on corrosion and corrosion prevention have been compiled by the National Association of Corrosion Engineers in a 346-page volume entitled *1948–1949 Bibliographic Survey of Corrosion*. The NACE Abstract Filing Index formulated by experts in the field of corrosion, is used to classify the material topically. The survey sells for $12.50, and orders should be sent to the NACE, 1061 N & M Building, Houston 2, Tex.

Power Plants, Norway. As a feature of its centennial celebration, Teknisk Ukeblad is issuing a comprehensive study of Norwegian power plants. Technical descriptions of the various plants and three general papers make up the 440-page anniversary volume. Called *Norske Kraftverker*, the volume may be ordered from Teknisk Ukeblad, Kronprinsensgate 17, Oslo 9, Norway. It is priced at 125 kr. with a 6-kr. charge for postage.

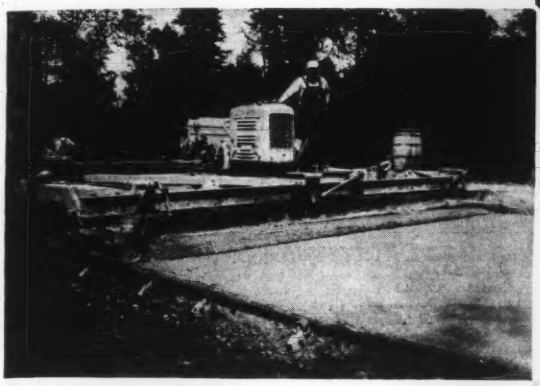
Prestressed Concrete. Availability of a *Bibliography on Prestressed Concrete* is announced by the American Concrete Institute. The 86-page book, which was prepared by ACI-ASCE Committee 323 on Prestressed Reinforced Concrete, lists 2,000 American and foreign reference on the subject, published in the past fifty years. A separate section lists some sixty United States, British, French, and German patents. Copies, selling for $2, may be ordered from the Institute, 18263 W. McNichols Road, Detroit 19, Mich.

Urban Heliports. A sixteen-page research report of the Institute of Transportation and Traffic Engineering at the University of California on the characteristics and weight of helicopters and planning and design criteria for ground and roof-top heliports is available without charge upon application to the Institute, Berkeley 4, Calif. The authors are Prof. Robert Horonjeff, A.M. ASCE, and Howard S. Lapin.

Better highways faster



SPREADER IN ACTION on the new Delaware River Extension of the Pennsylvania Turnpike, Bucks County, Pennsylvania.



FINISHING MACHINE makes second pass on new section of Pennsylvania Turnpike. Contractor: C. J. Langenfelder, Baltimore, Md. Cohesiveness is demonstrated by concrete roll ahead of screed.

Concrete was placed in near record time for the new Delaware River Extension of the Pennsylvania Turnpike. And to make a good job better, consistently uniform air contents, well within the specified limits, were obtained. With Duraplastic air-entraining portland cement, engineers can be sure of the protection of entrained air regardless of the possibility of human error or mechanical failure.

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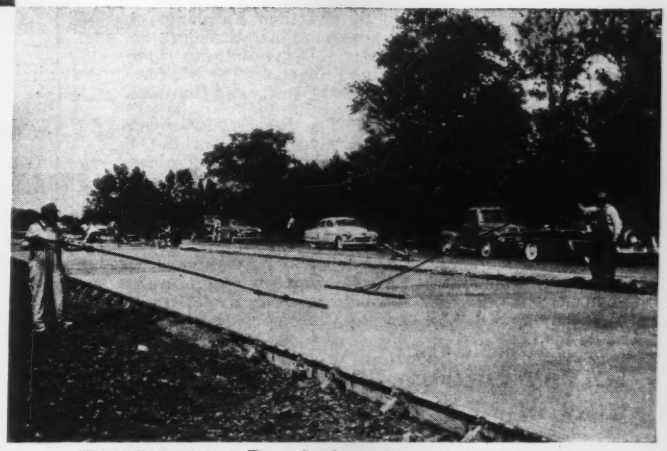

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SANITARY ENGINEER; A.M. ASCE; 44; B.A. Chemistry, B.S., Civil Engineering, C.E., Sanitary Engineering, University of Wisconsin; registered civil and chemical engineer, California; registered civil engineer in Illinois and Hawaii; 18 years of progressively important experience in all phases of sanitary engineering; presently employed as director of sanitary engineering division of large government organization; desires change to consulting or construction work in United States; experience includes extensive design, planning, management and direction. Will relocate. Available March 1, 1955. Will consider position as superintendent of large utility in water or sewer treatment field. C-13.

CHIEF ENGINEER; J.M. ASCE; 34; Ph.D., license; 12 years' experience in routine and difficult design of buildings, bridges, underground and water-front structures. Specialized in soils and foundations; desires position as project engineer, division head, or professor. Excellent references. C-14.

ENGINEER, C.E.; J.M. ASCE; P.E.; 6 years, concrete construction experience including estimating, pricing, detailing, reinforcing, steel, designing forms, field supervision and layout, and design of reinforced concrete structures. Four additional years' background in airfield construction, structural steel fabrication and design. C-15.

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HEAVY CONSTRUCTION ENGINEERS, young, graduate, civil, interested in field construction, with above average academic records and a maximum of 5 years' experience, for a long-range heavy construction program in eastern states. Initial training at home office, followed by field assignments. Applicants must be willing to relocate. Salary open. Location, Pennsylvania. W-513.

DISTRICT CONSTRUCTION MANAGER, graduate engineer, with several years' experience in the mechanical and building phases of construction, to supervise and direct project superintendents on both building and mechanical type projects, including analysis of costs and methods. Experienced as a district construction supervisor or project manager on several large projects desired. State salary required. Location, Midwest. W-519.

STRUCTURAL DESIGNER, for the design of complete project principally in connection with marine facilities of all types, major paper mill additions and alterations, fertilizer plants and other material handling problems. Thorough knowledge of the design of structures (steel, concrete and wood) and experience in accommodating mechanical installations into these structures. Location, South. W-526.

SALES PROMOTION EXECUTIVE, 35–45, civil or mechanical graduate, with sales, sales promotion and application engineering experience covering steel products for construction industry. Salary open. Location, Pennsylvania. W-545.

STRUCTURAL STEEL ESTIMATOR, with good technical and practical background in structural steel estimating. Experience with other types of building materials desirable. Location, Pennsylvania. W-594.

INSTRUCTOR OR ASSISTANT PROFESSOR, with at least M.S. in civil engineering, to teach sanitary and municipal engineering courses. Salary open. Location, Southwest. W-617.

DESIGN ENGINEERS, (*a*) Design Engineer, mechanical or civil graduate, with at least 5 years' experience covering design and layout of materials handling equipment covering ore and bulk materials. Salary, $6,000–$7,000 a year. (*b*) Design Engineer, mechanical engineering graduate, with at least 5 years' experience covering underground piping in sanitary chemical and allied fields. Salary, $6,000–$7,000 a year. (*c*) Structural Designer, civil engineering graduate, 40–45, with at least 10 years' experience covering heavy structural design on mill buildings and process industry plants. Salary, $8,000–$10,000 a year. Location, New York, N.Y. W-622.

SANITARY ENGINEER, 25–30, with a bachelor's degree in either civil or chemical engineering. Should have several years with a consulting engineer engaged in general field and office work. Must be capable of writing technical information as well as accurately appraising hydraulic designs of distribution systems and treatment plants. Will be employed in the sales promotional section of the company. Salary open. Location, Massachusetts. W-624.

CONSTRUCTION ENGINEER, 30–35, civil engineering graduate, with estimating and building construction experience, for office and field duties with institution. Must be able to write good reports. Salary, $6,500–$7,000 a year. Location, New York, N.Y. W-640.

TOWN ENGINEER, graduate civil, with New York State license, at least 5 years' experience in municipal, county or state engineering work. Will work on problems relating to town drainage, road construction, building construction, zoning and related activities. Salary, $5,500–$6,500 a year. Must be a resident of New York State for at least one year. Location, upstate New York. W-666.

SOILS ENGINEER, young, civil graduate with experience on highways and general construction. Salary, $5,000–$6,000 a year. Location, Queens, New York. W-702.

CIVIL ENGINEER, to 35, to work for large electric power utility on transmission line layout and design. Experience preferred. Some travel required. Send resume of education experience and references. Location, New York, N.Y. W-739.

MUNICIPAL ENGINEER, registered, with executive ability to manage the Public Works Department in a small but growing town of 9,000. Experience with water and sewage systems is a necessity. Location, Pennsylvania. W-743.

ASSISTANT OR ASSOCIATE PROFESSOR, in civil engineering, with M.S. degree and teaching experience. Primary field of interest in hydraulics but should be able to teach water supply and sewerage treatment. Must be capable of taking over and further developing very fine hydraulics laboratory. Salary open. Location, South. W-765.

JUNIOR CIVIL OR MECHANICAL ENGINEER, with municipal engineering experience covering water works systems to make surveys, distribution studies and prepare reports. Considerable traveling. Salary open. Location, throughout the United States. W-772.

HEAVY CONSTRUCTION ENGINEER, graduate, about 35, to design construction facilities and assist estimator. Must have 5 years' field experience on bridge or foundation work and 5 years as a draftsman and designer on work of magnitude. Location, western Pennsylvania. W-805.

CONSTRUCTION SUPERINTENDENT, preferably with license, civil or architectural graduate, with at least 10 years' building construction experience on apartments, commercial and institutional buildings, to act as resident engineer and general supervisor of construction of large 3-story suburban office building for consulting firm. Salary $12,000 a year. Location, Connecticut. W-818.

ENGINEERS. (*a*) Structural Design Engineer with at least a master's degree, familiar with stress analyses of highly redundent steel structures (orthodox methods and methods of successive approximation, must be familiar with relaxation methods). (*b*) Design Engineer, familiar with standards, specifications and codes used in steel structures and experience in checking engineering and shop drawings for steel structures such as bridges, industrial buildings, movable bridges, piers, plate girders, ships, etc. (*c*) Structural Design Engineer, master's degree, experienced in the design of all welded steel structure partially welded and partially riveted structures, high tensile bolted connections, and with up-to-date knowledge of problems of corrosion fatigue, brittle failures, effect of low temperatures, crackless plasticity, stress concentration problems, impact problems, etc. (*d*) Design Engineer, familiar with the design of steel tanks, elevated water towers, vessels, or similar structures. Location, New York, N.Y. W-823.

CIVIL ENGINEER. (*a*) Associate, graduate with 2 years' or more experience in highway work, office and field. Salary, $4,812–$5,952. (*b*) Assistant, graduate with minimum one year experience, in surveying or drafting, for road construction and maintenance department. Salary, $4,104–$5,076. Location, northern California. S-106.

THE ENGINEER'S CREED

The American Society of Civil Engineers announces the availability of a new supply of "The Engineer's Creed," which originally appeared in the November, 1948 issue of CIVIL ENGINEERING. This new de luxe reprint, 8½ x 11", has been produced on lightweight parchment, and is suitable for framing.

Copies available at $1.00 each
Quantity prices on request

American Society of Civil Engineers
33 West 39th Street, New York 18, N.Y.

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Challenging problems in:—

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Openings at both junior and senior levels. For additional information forward resume to:

Missile & Control Equipment Dept. C
Engineering Personnel
NORTH AMERICAN AVIATION INC.
12214 Lakewood Blvd.
Downey, Calif.

PLANT EQUIPMENT ERECTION SUPERINTENDENT

An established food products manufacturing company has an immediate opening for a plant equipment erection superintendent. This man preferably should be an engineering graduate with experience in plant construction and machinery erection. We would prefer that this experience be in the food industry. The applicant would headquarter in Minneapolis but must be willing to do extensive travelling. Responsible experience in negotiating subcontracts and co-ordinating work among subcontractors is absolutely necessary.

A full resume of past experience should accompany each application and should be mailed to

BOX 243
CIVIL ENGINEERING
33 West 39th Street
New York 18, N. Y.

Advertisement

PRESIDENT wanted for large engineering collective bargaining organization in Northwest. Applicant must be U. S. citizen, experienced engineer of professional caliber. Must have experience in responsible activity in collective bargaining or equivalent experience or training in Industrial Relations. Starting salary between $7500 and $10,000, dependent on experience and ability. Upon receipt of preliminary application, more detailed information will be promptly dispatched. Address application to Seattle Professional Engineering Employees Association, 3106 Arcade Bldg., Seattle, Wash.

CITY ENGINEER

Unusual opportunity for graduate civil engineer, or equivalent, with professional license, in southern Pennsylvania city. Experience is essential in land surveying, street layout, sanitary and storm water drainage, and related work. Experience is desirable in application of zoning laws and sub-division control. Successful applicant would be in responsible charge of Engineering Department, supervising survey crew and draftsmen; and would be expected to deal with the public in the many problems arising in the operation of a City Engineering Department.

Attractive salary, pleasant working conditions, permanent position for right man. No political interference. Man under 40 preferred. Reply should state age, background, and specific experience in the above mentioned fields.

Reply to Box 241,
CIVIL ENGINEERING
33 West 39th Street
New York 18, N. Y.

Applications for Admission to ASCE, November 20, 1954–December 11, 1954

Applying for Member

EMILIANO AGUINALDO y GARAZA, Manila, Philippines
JAROSLAV BRCEK, Merida, Venezuela.
GUNNARD WILLIAM CARLSON, New York, N.Y.
KIT LAM CHEUNG, Hong Kong, China.
EDWARD SCHANCK COLLINS, Dallas, Tex.
HAROLD COOPER, New York, N.Y.
MAURICE LAROY COTTA, Portland, Oreg.
LEE DENNISON, Port Jefferson Station, N.Y.
ROBERT JOHN FLEMING, JR., Philadelphia, Pa.
CHARLES FREDERICK FOWLER, Lincoln, Neb.
HARRY LOWE FOX, Mobile, Ala.
LEE EDWARD HAM, Burlingame, Calif.
CHOWDHRY ABDUL HAMID, Lahore, Pakistan.
ARTHUR BREEDE HAZEL, Poplar Bluff, Mo.
WILLIAM ARTHUR HENDERSON, Boston, Mass.
ROBERT BAKER HICKOK, Albuquerque, N.M.
FREDERICK CHARLES LOWY, New York, N.Y.
WILLIAM ARTHUR MARTIN, Cleveland, Ohio.
JAMES ULMER MOORHEAD, Portland, Oreg.
KARL VIKTOR TORE NILSSON, Stockholm, Sweden.
JAMES WESLEY PORTER, San Jose, Calif.
WILLIAM WHITE RAGLAND, Arlington, Va.
RUDOLF RITSCHIE, Pittsburgh, Pa.
HAROLD ROMER, New York, N.Y.
BANCROFT TERRY, Blytheville, Ark.
SAMUEL PARISH TURNBULL, College Park, Md.

Applying for Associate Member

MANUEL AMAYA-LECLAIR, Managua, D.N. Nicaragua.
ALFRED HANDLEY ASHWORTH, North Vancouver, B.C., Canada.
MALCOLM EDMOND AUSTIN, Boston, Mass.
SURENDRARAI JADURAM BHATT, Chicago, Ill.
ROBERT ANTON BLANK, Chicago, Ill.
KENNETH JOSEPH BORST, New York, N.Y.
CURTIS MAITLAND BROWN, San Diego, Calif.
JAMES PHILIP BRUNER, New York, N.Y.
GERALD FITZGERALD CARDNO, Queensland, Australia.
JOSEPH ANTHONY CHRISTE, New York, N.Y.
FRASER MCDOWELL CROFTS, Los Angeles, Calif.
SAMUEL NEAL DAVIS, Ottumwa, Iowa.
RUDOLPH BASIL GALIBER, Charlotte Amalie, Virgin Islands.
CLYDE GRAHAM GATES, Sacramento, Calif.
HARRY THOMAS GRAHAM, Cincinnati, Ohio.
MALCOLM DAVID HALE, Indianapolis, Ind.
LEWIS HALL HELM, Clarksburg, W.Va.
JOHN JOSEPH HENNIGAN, JR., Syracuse, N.Y.
DWIGHT JACK HERNDON, Agana, Guam.
LOYLE CARL HOLDEN, South Gate, Calif.
JAMES GEORGE JOHNSTONE, Lafayette, Ind.
HAROLD LAWRENCE JOYNES, Sacramento, Cal.
STEVE LUPKOVICS KENEZ, Hamilton, Ont., Canada.
SIMON KIRSHEN, Boston, Mass.
JOHN RANDOLPH LEAMAN, JR., Hornsbyville, Va.
KENNETH HOLLAND LITTLE, New York, N.Y.
IAN BRINE MACKINTOSH, London, England.
CHARLES FOSTER MARSHALL, Lancaster, S.C.
LOREN CHARLES MILLER, Cleveland, Ohio.
CORNELIUS QUINCY NEVITT, Atlanta, Ga.
DAVID KNOX NEWMAN, Jacksonville, Fla.
KAVI PURANASAMRIDDHI, Washington, D.C.
JOHN FRANCIS ROSS, Midland, Tex.
RISTO RURIK RUSO, Helsinki, Finland.
ALEXANDER FRANK SILADY, Kansas City, Mo.
MARVIN JOHN SLAUGHTER, Juneau, Alaska.
SHERMAN KING SMITH, Waterville, Maine.
AUNG THAN, Rangoon, Burma
GUY FRANKLIN VANSANT, JR., Frankfort, Ky.
JOHN ROLLIN WATSON, JR., Valdez, Alaska.
ROBERT KEARNEY WILLIAMS, JR., Richmond, Va.
BENJAMIN AUGUSTUS WRIGHT, JR., Los Angeles, Calif.

Applying for Junior Member

TERRY CLEEMONT ADAMS, Knoxville, Tenn.
LOUIS REXROAT ANDERSON, Boston, Mass.
KENNETH JUDSON BOEDECKER, JR., East Orange, N.J.
J. FRANK BONELL, Salt Lake City, Utah.
ERNESTO D'ESCRIVAN-GUARDIA, Caracas, Venezuela.
OSCAR ESCOBAR ROJAS, Bogota, Colombia, S.A.
EARL ROBERT GENTLES, Harrisburg, Pa.
LAWRENCE HIRSCH, Austin, Tex.
EDWARD EVERETT HORTON, III, Los Angeles, Calif.
VIRGIL CARLYLE JOHNSTON, Atlanta, Ga.
HERBERT HENRY MAUCHLY, Toledo, Ohio.
PETER JOHN MOORE, Urbana, Ill.
DANIEL JOSEPH MURPHY, E. Chicago, Ind.
LI SEUNG PING, Hong Kong, China.
ALAN WAYNE POTTER, Jacksonville, Fla.
WILLIAM JAMES ROLO, Lancaster, Ohio.
WILLIAM SHENK, Baltimore, Md.
HERBERT STOBO SHERA, Toronto, Ont., Canada.
STEPHEN JOSEPH SURMAN, Aurora, Minn.
KRISHNAMACHARY VEERARAGHAVACHARY, Madras, India.

[Applications for Junior membership from ASCE Student Chapters are not listed.]

AIRCRAFT ENGINEERS

With Experience
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Analysts

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STRUCTURES
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Dynamic Analysis—Systems Engineers

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TOOL ENGINEERS

Recent Graduates with Aeronautical, Mechanical, Civil or Engineering Physics Degrees may qualify.

Proof of U. S. Citizenship Required

APPLY IN PERSON

OR SEND RESUME TO:
Engineering Personnel Dept.

INTERVIEWS AT
Employment Office
South Oyster Bay Road
North of Railroad

Monday thru Friday
8:30–11:30 AM; 1:30–3:30 PM

GRUMMAN AIRCRAFT
Engineering Corp.
Bethpage, N. Y.

EQUIPMENT, MATERIALS and METHODS

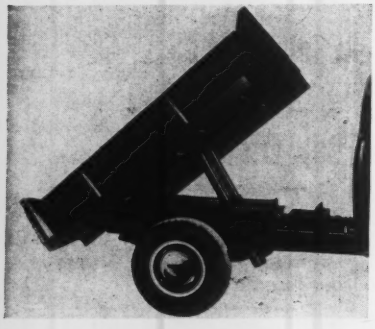
NEW DEVELOPMENTS OF INTEREST AS REPORTED BY MANUFACTURERS

Oscilloscope Camera

FOR CONTINUOUS RECORDING OF OSCILLOSCOPE TRACES a new high speed 35 mm camera, Model OC-1, has been announced. Weighing only six lbs, with a film capacity of 100 ft, the camera may be mounted directly on the Bezel of any five in. oscilloscope. The installation features simultaneous binocular viewing and recording, illuminated identification card and flashing lamp time reference. The film transport rate may be set between 1 and 300 in. per second by means of a variable remote motor control. Lower speeds can be achieved by gear substitution and higher speeds up to 400 in. per second can be reached with special starting acceleration control. Less than 15 seconds are required for removing exposed film and reloading with daylight loading spools. The film consumed in starting or stopping at maximum speed is less than two ft. **Brea Instruments, CE 1-108, P.O. Box 248, Brea, Calif.**

Hydraulic Hoist

AN HYDRAULIC HOIST HAS BEEN DESIGNED for installation on 1/2, 3/4 and one ton trucks. Known as Model 334N, the

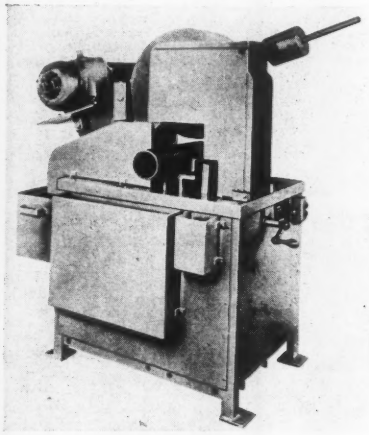


Model 334 N

hoist can be mounted under any pick-up body, as well as any platform body up to 9 ft in length or light duty dump body up to 8 ft long. Rated capacity of the hoist is four tons, depending on body length and pivot. Suitable for installation on trucks having cab-to-axle dimensions of 46 to 60 in., Model 334N provides a dumping angle of 40 degrees. The location of the twin 3 in. ram-type hoist cylinders is ahead of the truck's rear axle. Mounting height is reduced to 4 in. with wheel housing-type bodies on standard 3 in. structural steel channel longitudinals. A double shaft pump and a rotary control valve promise fast dumping action and positive hoist control. **The Galion Allsteel Body Company, CE 1-108, Galion, Ohio.**

Abrasive Cutting Machine

A DRY ABRASIVE CUTTING MACHINE, capable of a speed of approximately three seconds per sq in. of material, is now being produced. Known as the Sever-All, Model No. 28, it is available in both stationary and portable types. This abrasive



Model No 28

cutting machine is designed to handle material up to 4 in. at 90° to axis for solid steel, 8 in. × 90° to axis for channels. These specifications are based on using an 18 in. diameter cutting wheel with a 10 hp motor, work size cutting capacity being reduced when a smaller diameter cutting wheel and less hp is used. The wheel is lowered into the work by a hand lever. The one in. diameter wheel spindle is driven by "V" type belts. Since the Sever-All is an oscillating type machine, the amount of abrasive wheel contact is reduced and cutting is done with a minimum of pressure on the abrasive wheel. A double-acting work holder automatically positions the material in the center of the work support. The material is then clamped at both sides of the cutting wheel by a hand operated crank handle. **American Chain & Cable Co. Inc., CE 1-108, 929 Connecticut Ave., Bridgeport 2, Conn.**

Scraper

A 15 CU. YD. STRUCK, 19 cu. yd. heaped, capacity rubber-tired four-wheel scraper has been added to a line of pull-type scrapers. The new unit is cable-controlled and features positive forced ejection. It provides a 9 ft. 8 in. wide cut with its carbon steel heat-treated offset type cutting edge. Overall length of Model 315 is 33 ft. 5 in. and the width is 11 ft. 6 3/4 in. The overall height is 8 ft. 8 in. with blade on the ground, and 9 ft. 2 in. when bowl is raised. **Allis-Chalmers Mfg. Co., CE 1-108, Tractor Division, Milwaukee, Wisc.**

Electric Drill

VERSATILITY IS THE KEYWORD for the new portable electric drill, Model 137. Using high speed twist drills, it quickly penetrates wood, steel and other metals, plastics, all types of composition board, and even concrete. Using abrasive discs, this same tool sands wood or metal, removes paint and varnish. A wire brush attachment removes rust from tools and other equipment. A special bracket and grinding wheel converts the drill into an electric bench grinder. A 5 in. lamb's wool bonnet equips the drill for waxing and polishing. A cloth buff enables it to polish metal articles. A vertical drill stand is also available as optional equipment for converting the tool into a drill press. Model 137 Porter-Cable Drill offers several quality features: a universal AC-DC, 115-volt motor; spur-type reduction gears; an idling speed of 2300 RPM; gripping power provided by a precision-ground gear type chuck which prevents slipping: a chuck key is attached to the cord. **Porter-Cable Machine Company, CE-108, 52 Exchange St., Syracuse 8, N.Y.**

Rear Dump

TO MEET THE NEED for a greater capacity hauling unit in the size powered by

Model C

the Model C Tournapull, the capacity of the Model C Rear Dump has been increased from 18 to 22 tons. In terms of yardage, the struck capacity of the new unit now is rated at 14.7 yd with a heaped capacity of 17 yd. To provide for this four-ton increase, ten in. have been added at the top to the inside width and two in. to the top length. The overall length of the entire machine in traveling position is now 30 ft, making it longer than before. **Le - Tourneau - Westinghouse Company, CE 1-108, Peoria, Ill.**

Equipment, Materials & Methods (Continued)

Heavy-Duty Shovel

INDEPENDENT TRAVEL WHILE SWINGING minimizes the danger of quarry work, since this 3/4 yd shovel can move away quickly from the face of the rock when poorly blasted sections are knocked down. Increased production and reduced wear and tear on the shovel are provided by a fluid coupling whose slippage is increased or decreased at any throttle setting to meet varied rock conditions when unblasted rock mixed with dirt is excavated. The positive, chain-driven crowd has its own shaft so that a drop ball for breaking

3/4 yd Shovel

big rock can be operated from another drum, instead of hooking the ball to the shovel teeth. Power steering and an automatic reverse travel lock are other features of this heavy-duty shovel. **Gar Wood Industries, Inc., CE 1-109, Wayne Mich.**

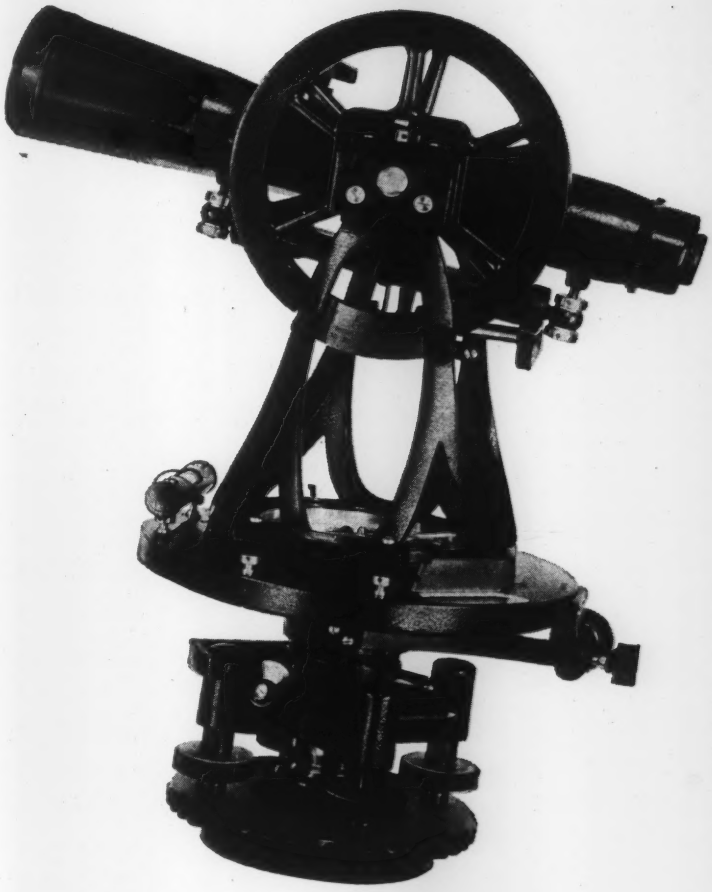
Grader Attachment

USEFUL IN CASTING, STRIPPING, LOADING AND TERRACING is the elevating grader attachment. In casting, the unit handles 1,000 to 1,800 cu yds per hour. It features a 30 in. adjustable disc of special alloy steel, which feeds onto a 42 in. wide conveyor belt. The standard 16 ft carrier is readily extended to 19 or 22 ft by the addition of 3 ft sections. Disc and carrier positions are hydraulically controlled from the cab. Especially designed for Warco 4D-85 and 4D-115 motor graders, the attachment can be adapted to either old or new machines. **W. A. Riddell Corp., CE 1-109, Bucyrus, Ohio.**

Tracing Paper and Cloths

SUPERIOR TRANSLUCENCY, PERMANENCE, UNIFORMITY, penciling, and erasability are being claimed for six improved tracing papers and cloths. Tests on the three tracing papers show that they are odorless and completely "cured," so that they will not

(*Continued on page 111*)



The Gurley Transit
Has More Useful Features
Than Any Other Instrument

Check these features:
- *As much as 25% lighter than other makes*
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- *Integral plate and standards structurally strong, rigid—no screws to loosen*
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- *Reversion telescope level*
- *Most accurately graduated circles of any instrument today*

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Variable Power, now standard on all Gurley transits and levels, permits wide range of magnification with *one* eyepiece. Change your magnification to suit weather and light conditions. Built-in haze filter. *Write for "Facts on VP."*

W. & L. E. Gurley, 518 Fulton St., Troy, N. Y.

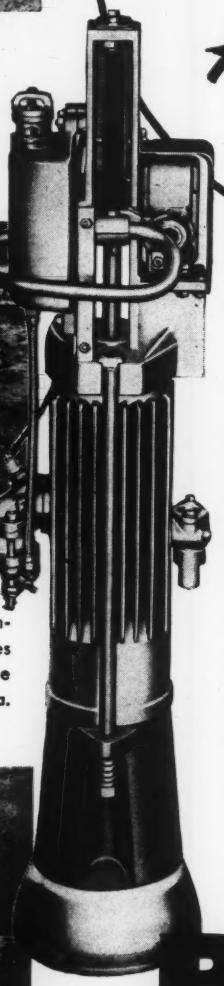
FOR SOIL COMPACTION IN RESTRICTED AREAS!

BARCO *is the Answer!*

CALIFORNIA HOSPITAL—Ability to work inside buildings and in other restricted areas makes the Barco Rammer invaluable. The job pictured above is on the Peninsula Hospital near Millbrae, California. *Contractors:* Williams & Burrows and Carl N. Swenson Company. (*Photo:* CONSTRUCTION ILLUSTRATED.)

GEORGIA HOUSING PROJECT—With Barco Rammers, you can finish fill to high degree compaction immediately for quicker completions and important savings in cost. This is why the J. A. Jones Construction Co. used seven Barco Rammers on the Lakewood Housing Project at Atlanta, Georgia. (*Photo:* DIXIE CONTRACTOR.)

NEW YORK DAM—Exacting specifications for soil compaction on the Downesville Dam project of the New York City Board of Water Supply were easily met by Barco Rammers used by Carlo Bianchi & Company. (*Photo:* CONSTRUCTIONEER.)



SOIL COMPACTION is the key to *better construction* on important building projects throughout the country—and on these jobs, BARCO IS THE ANSWER! Time after time, it has been proven that no other type of equipment can match BARCO PERFORMANCE.

The Barco Rammer is a completely self-contained unit; no auxiliary or extra equipment is required. On area tamping, where specifications call for 95% to 97.5% (modified Proctor) compaction, one man can average 20 to 30 cubic yards of fill per hour, day after day.

If you are not already using the Barco Rammer for soil compaction work, find out about it now! *Worldwide Sales and Service.* BARCO MANUFACTURING COMPANY, 561B Hough St., Barrington, Illinois. (*Near Chicago*).

BARCO

"Pegson" Gasoline RAMMER

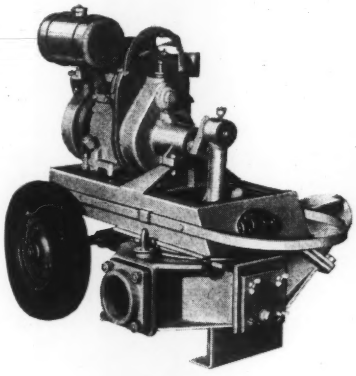
For Soil Compaction Close to Walls, Culverts and Abutments — in Trenches, Ditches

FREE ENTERPRISE — THE CORNERSTONE OF AMERICAN PROSPERITY

become brittle or lose proper transparency. Outstanding among the three tracing cloths is the Whitney No. 378, which is the first dual-purpose cloth that accepts both ink and pencil equally well. Ink lines do not chip or flake off, and pencils neither skip nor damage the surface. Obtainable in blue and white, it also features water repellance, making it impervious to common solvents, spilled liquids, and perspiration stains. **The Charles Bruning Company, CE 1-110-11, 4700 Montrose Ave., Chicago 41, Ill.**

Closed Diaphragm Pump

A FOUR IN. CLOSED DIAPHRAGM PUMP is designed for application where the fluid to be pumped cannot be effectively handled with a centrifugal pump because of a high solids content. Straight line flow, which



4 Inch Pump

helps in keeping intake and discharge valves flushed and free of debris at all times, is a feature of this Rex Pump. Power has been increased with a Wisconsin AKN 6.2 H.P engine. The pump is also equipped with an adjustable towing handle **Chain Belt Company, CE 1-111, Milwaukee 1, Wisconsin.**

Rotary Trowel

A ROTARY TROWEL WITH A STATIONARY GUARD RING intead of the rotating ring not only makes the machine safer, but it also allows the operator to work right up to walls and other obstructions. The concrete achieves a smoother surface because the blades are not attached to a ring that can be bent out of shape. No extra handle is needed when lifting the machine, since the machine can be picked up at any point on the guard ring. As a safety asset, a control is used which stops the machine, when the operator releases the handle, without stopping the engine. The Model G34 is 34 in. in diameter and has a 4 cycle 2 hp gasoline engine. **The Stow Manufacturing Co., CE 1-111, 93 Shear St., Binghamton, N.Y.**

CEMENT GUN COMPANY RESTORES 15 MILLION GALLON RESERVOIR WITH "GUNITE"

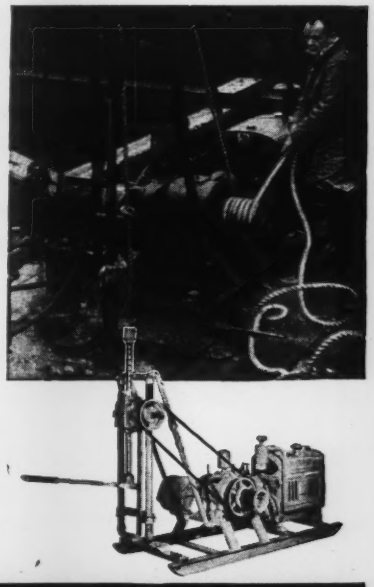
This 15 million gallon reservoir of a large Virginia municipality was made "better than new" with a 2" thick "GUNITE" lining placed by a Cement Gun Company crew. The structure had been leaking badly through construction joints and required grouting behind the slopes in order to fill voids formed by the leakage. With reinforcing mesh in place, we applied "GUNITE" to the slopes and out 8 feet on bottom. Results were so pleasing to city officials that we were asked to repair an adjacent 5 million gallon reservoir.

Free Bulletin B3000 illustrates many examples of repair and new construction completed with "GUNITE" by the Cement Gun Company. A request on your letterhead will bring a copy by return mail.

CEMENT GUN COMPANY
"GUNITE" CONTRACTORS
GENERAL OFFICES – ALLENTOWN, PA., U. S. A.
MANUFACTURERS OF THE "CEMENT GUN"

acker **Portable, Power Operated Soil Sampling Rigs**

Acker power operated soil sampling rigs combine into a compact, portable unit a standard power plant together with powerful hoisting winch and pump. Two models are available — Acker Model RGT for light duty and Acker RG for heavy duty service. These relatively inexpensive units are ideal for soil sampling, jetting and driving pipes or piles.



More for Your Money!

Add an *Acker rotary drill head* for rock coring and foundation test boring.

The Acker Model SK rotary drill head when combined with Acker RGT and RG rigs make an ideal unit for rock coring and foundation test boring. For complete information, write today for bulletin **28-CE.**

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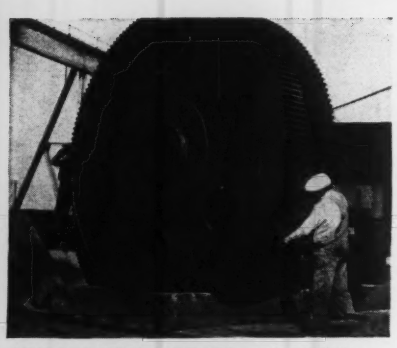

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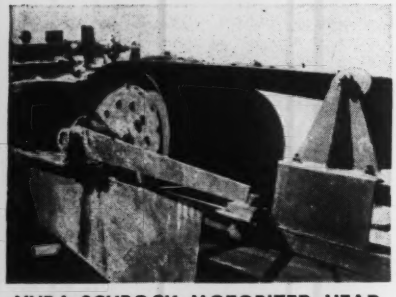

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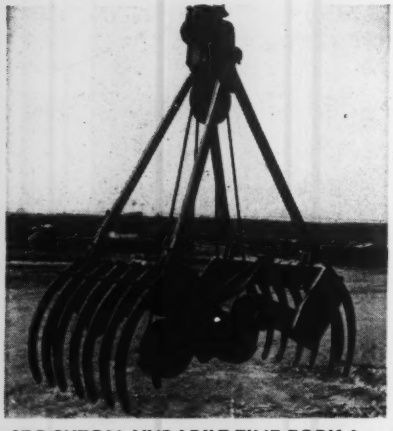

STOCKTON-YUBABILT TINE FORK for handling kelp, steel shavings, etc., has same powerful closing action as Yubabilt Power Arm Clamshell.

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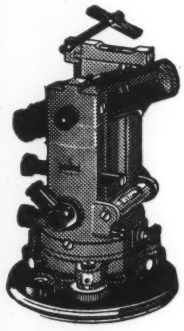
RAPIDEX, THE REVOLUTIONARY SYSTEM OF CONSTRUCTION for roofs and floors, is now manufactured with a tongue and groove edge which guarantees automatic alignment of the slabs with flush top and bottom surfaces. A special lime is used in the formulation of the concrete block units which has improved the strength, appearance, and water resistance of the block. Rapidex slab units are 16 in. wide, available in 6 in. and 8 in. depth and in lengths up to 30 in. for the 8 in. depth. The individual blocks that are the component parts of each unit slab section are made of coarse and fine Haydite aggregate and Portland cement. The Haydite concrete in these units has a compression strength of 3,000 lbs. per sq in. after 28 days. When the joints are properly grouted, the entire deck area becomes an integral slab because of the "tongue and groove" joint between the unit slabs. After being accurately cast, the Rapidex blocks are precision ground on the compression faces to micrometric tolerances. After grinding, the blocks are assembled with core holes aligned. Steel reinforcing rods are centered in the two bottom core holes, and high strength concrete grout is pumped under pressure through the core holes, surrounding and completely embedding the steel. By "pre-arching" the slabs, deflection due to dead load is offset, which gives a longer spanning ability. Eight in. Rapidex with two one in. diameter steel re-inforcing rods will carry a live load of 59 lbs. per sq ft on a 29 ft 4 in. clear span. Need for intermediate structural framing is often eliminated. Rapidex is manufactured in lengths up to 30 ft, and is delivered ready for immediate use. **The Spickelmier Co., CE 1-112, Indianapolis, Indiana.**

Hydraulic Jacks

A SERIES OF JACKS WITH capacities from 50 to 400 tons and with strokes up to 48 in. has been added to an existing line of hydraulic products. Intended primarily for jacking large diameter steel and concrete pipe, these jacks are designed for 6000 PSI pressure at capacity, and feature hydraulic return, heat treated alloy cylinders for minimum weight, large diameter ram shanks for rigidity, low friction seals and protective ram wipers. Jacks of this type, with gasoline or electric driven pumps, are being added to the company's supply of rental equipment which, until recently, has included only single acting compression jacks (ranging in capacities from 10 to 600 tons and strokes from 2 in. to 17 in.) and hand operated pumps. Because more and more contractors are discovering the advantages of renting jacking equipment instead of purchasing jacks, the rental service has been extended to meet the demand. All units are inspected and completely factory serviced after each job. **Richard Dudgeon, Inc., CE 1-112, 789 Bergen St., Brooklyn 38, N.Y.**

Optical Transit

FOR SURVEY OBSERVATIONS, such as tachymetry, traversing and triangulations, the Askania Transit TK is being employed. It is used for setting out works in highway, railroad and bridge construction, etc. It is also being used for



TK Transit

astronomic tie-in measurements. Both graduated circles of the reading microscope, as well as the micrometer scale, can be read in any position of the telescope. The repeating lever not only enables fine-orienting of the horizontal circle and direction transfer, but also permits repetition of angles. **Geo-Optic Company, Inc., CE 1-112, 170 Broadway, New York 38, N. Y.**

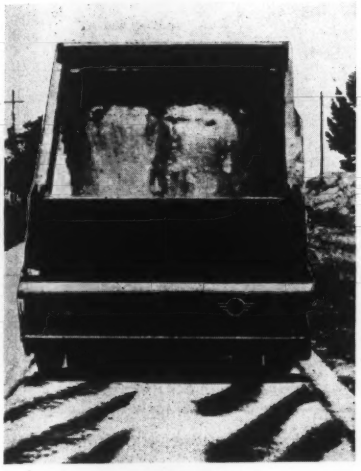
Boom Stops

IN CONSTRUCTING DEXTER DAM near Eugene, Oregon Rud-o-Matic Thomas boom stops were used in order to hoist precast bridge sections onto the dam structure. These boom stops, are built in three sizes. Model 5000 is for use with small cranes up to 20-ton capacity. The M-10,000 is designed for cranes of 20 to 100-ton capacity, while a third model, the M-15,000, is engineered for use on cranes with extra long booms operating under unusual conditions. Operation of the automatic boom stops is simple. Dual spring-loaded rams, mounted on the "A" frame of the crane, provide a cushioning effect that checks critical movement in the event a load cuts loose and the boom whips back. The two rams allow 12 in. travel as they arrest boom motion. Pressure on the M-5000 increases from about 250 lbs up to 5000 lbs, while the M-10,000 permits increased pressure to 10,000 lbs. Two vacuum-actuated valves, mounted at the base of the boom, operate the boom clutch and master clutch. When the operator raises his boom to an angle of 85° to 88°, the number one valve releases friction to stop boom travel. The number two valve checks the boom at a 90° angle. If the operator two-blocks the hoist line and pulls the boom back, the number two valve immediately releases the motor's master clutch. Protection for personnel and equipment is the prime feature. **McCaffrey-Ruddock Tagline Corp., CE 1-112, Los Angeles, Calif.**

Equipment, Materials & Methods (Continued)

Highway Spreader

ECHELON SPREADING OF SALT, cinders, sand and calcium chloride for ice control work has been solved by the Model J Highway Spreader. The new spreader which offers an option of echelon or blanket spreading is also equipped to handle sand, chips and pea gravel for seal coat work. Built to fit any width dump body, the spreader is attached to the truck frame, eliminating any weight on the dump body itself. The dump body may be raised or lowered regardless of the amount of material in the spreader hopper. Power is provided on



Model J Spreader

the Model J by two traction tires, which put the drive in motion, when they come in contact with the inside truck dual as dump body is raised. The automatic transmission causes it to shift itself into proper direction and also eliminates the use of manual controls. **Highway Equipment Company, Inc., CE 1-113, 616 D Ave., N.W. Cedar Rapids, Iowa.**

Steering Booster

DESIGNED FOR APPLICATION IN CONSTRUCTION machinery and in mobile and mining machinery, a compact hydraulic power steering booster has been announced. Compactness has been achieved in the new model by a servo control valve design and relocated hydraulic connections. The booster is available either with or without relief valve, and can be either factory installed or mounted on vehicles in service. Its installation is made easier because of reduced diameter and there is mounting adaptability provided by a symmetrical control ball stud housing that can be assembled in any one of four different positions. The steering booster transmits all road shock to the chassis. **Vickers Incorporated, CE 1-113, 1400 Oakman Boulevard, Detroit 32, Mich.**

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Prestressed Concrete Structures

By August E. Komendant, Consulting Engineer. 261 pp., 153 illus., $6.00

Statically Indeterminate Structures

By C. K. Wang, Assoc. Prof. of Civil Engr., Univ. of Colorado. 424 pp., 493 illus., $7.50

Mechanics of Engineering Soils

By P. L. Capper, Senior Lec. in Civil Engr., Univ. of London; and W. F. Cassie, Prof. of Civil Engr., Univ. of Dunham. Second Ed. 315 pp., 138 illus., $6.50

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Literature Available

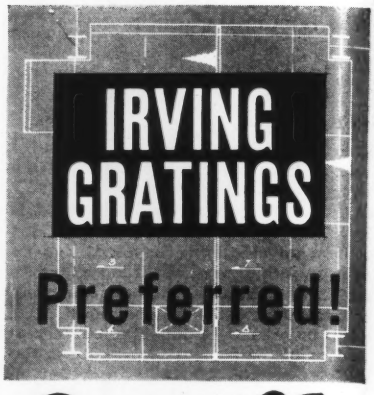
COLD WEATHER CONCRETING—An assortment of bulletins and a placard on cold weather concreting are now being issued to recommend job practices which will prevent many of the difficulties caused by cold weather. Some of the tips on this phase of concreting include: the addition of calcium chloride to the mix; use of high early strength cement; heating the water and concrete materials; heating the area in which the concrete is placed; and some special provisions for curing. **The Master Builders Company, CE 1-114, 7016 Euclid Ave., Cleveland 3, Ohio.**

STEEL-FRAMED STRUCTURES—Steel-framed structures that reflect the continuing growth of the west are shown in a recently published brochure. The new brochure contains numerous illustrations and valuable information on recently erected steel-framed structures in the Northwest, Central California, the Bay Area, Los Angeles, and Southern California. **Publications Department, Bethlehem Pacific Coast Steel Corp., CE 1-114, 20th & Illinois Streets, San Francisco.**

ARMORED MOTORS—A full-color publication describing armored motors, direct current types MD and MDP, 600 series, is now available. Designated GEA-4654C, the bulletin gives information on performance and maintenance features of heavy-duty motors. Diagrams and photographs illustrate various applications of the armored motors in the steel, lumber, oil, and construction industries. **General Electric Company, CE 1-114, Schenectady 5, N.Y.**

BITUMINOUS STABILIZATION—A manufacturer's method of road stabilization is explained in a fully-illustrated brochure. The booklet describes the mixing action on the aggregate; a way of reclaiming worn bituminous pavement; the necessary equipment; flat-bed mixing; soil stabilization. It also includes tables and specifications on a self-propelled Trav-L-Plant. **Seaman Motors, Inc., CE 1-114, 305 N. 25th St., Milwaukee 3, Wis.**

FORMING SYSTEM—Explaining the erecting and stripping advantages of the Symons Forming System is an 8 page illustrated catalog. The folder provides examples of their adaptability in the construction of battered walls, round tanks, reinforced high walls and mass production homes. What this system consists of is thoroughly described, including material on corners and fillers, pilasters, walers, waler ties, tightening wedge, short connecting bolt, two-way form tie and long connecting bolt and waler plate. The application of form hardware is illustrated in cutaway drawings and there is information about such supplementary equipment as safety shores, column clamps, bar ties and tie chairs. The care of forms and removing of form plywood, and the use of panel forms for slabs, columns and beams is also discussed in the catalog. **Symons Clamp & Mfg. Co., CE 1-114, 4249 Diversey Ave., Chicago 39, Ill.**



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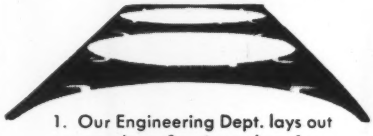

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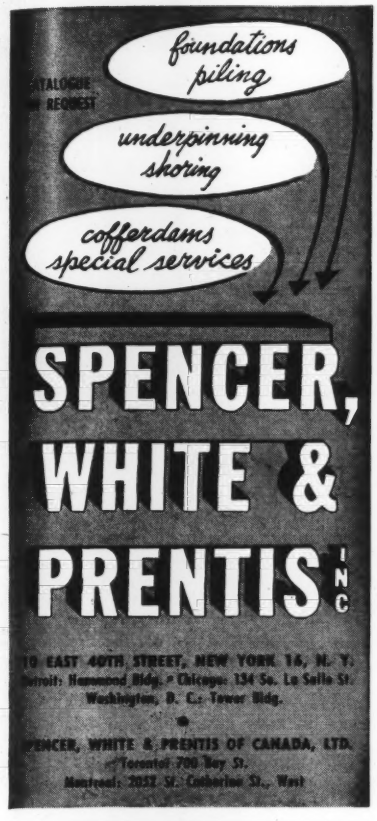
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Literature Available (Continued)

TIMBER DESIGN SERVICES—Various timber design services available, without charge, to architects and engineers planning structures of wood, are cited in a publication called "This is Teco." The illustrated booklet provides a panoramic view of the activities of Teco, the wood industries' service organization, in its promotion of the use of wood as an engineering material in light and heavy construction, and as a product material for industry. In addition to the typical designs of timber structures, the booklet describes the various Teco timber connectors that help contractors, builders, and fabricators produce wood structures economically and in compliance with the designers' specifications. There is also a description of the research and testing program in which comprehensive tests are made of new designs prior to their release as guides for the building professions. **Timber Engineering Company, CE 1-115, 1319-18th St., N.W., Washington 6, D.C.**

INDUSTRIAL TRUCKS—Pictured and described in a 12 page bulletin (5101C) are gasoline, Diesel and LPG industrial lift trucks in capacities ranging from 1,000 to 10,000 lbs. Listed in this bulletin is a handy chart which provides a check sheet of specifications for comparing the different models of gasoline powered equipment. Other pages give cut-away photographs which show such features as shockless steering, hydraulic brakes, hypoid gears and fluid coupling. **The Yale & Towne Mfg. Co., CE 1-115, 11,000 Roosevelt Blvd., Philadelphia 15, Pa.**

WIRE ROPE—For those who use or deal with wire rope there is now available a catalog of tables and data on the product and also a bulletin entitled "Ropeology." The bulletin shows special boat slings, barge tow line, logging operation, cable assemblies, slings and aircraft cable used on the super 18 Beechcraft and Boeing Jet Stratotanker. The catalog goes into finer detail about the classification of the wire rope, the different types of rope and general information on the subject. **MacWhyte Company, CE 1-115, Advtg. Dept., Kenosha, Wisc.**

MOTOR GRADER—A new two-color catalog covering the mechanical features and specifications of its Model D motor grader has been published. Job-application photographs tell the story of the many year-round jobs on construction and maintenance of roads and streets, and in general construction and building, that can be done with the grader. Illustrations include cutaway views of the complete Model D and of its 50-hp. "Power-Crater" engine. Important mechanical and construction features of the grader are also spot-pictured. **Allis-Chalmers Mfg. Co., CE1-115, Milwaukee, Wis.**

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The ¾-cu. yd. Crescent was powered by a two-drum hoist. Maximum span was 700 feet. One man handled the entire trenching operation. A second man was used occasionally to check the depth of the cut. Material pulled in by the scraper was removed by a small clamshell.

For more information and some new ideas, write for Field Report 219, Scrapers with Boom Machines, Field Report 209, Scrapers with Tractors and Catalog J.

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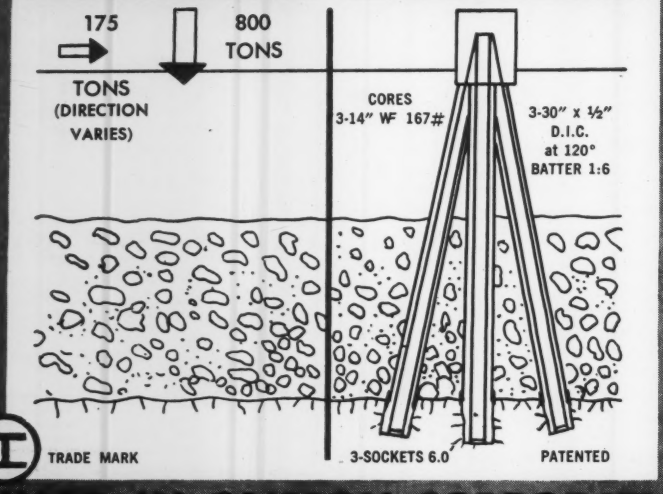

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Literature Available (Continued)

ELECTRIC HOISTS—The heavy duty construction and operational features of a new line of electric hoists are illustrated and explained in a six-page folder. Capacities of four to 15 tons are covered, although the complete line ranges from three tons to any desired capacity. A large spread gives a cutaway view showing the detailed engineering of the hoist. Special line drawings show two of the hoist features: the combination motor-load brake and the gear reduction design. Photographs are devoted to applications where hoists are shown handling large, heavy lifts, such as steel plate, forgings and other heavy manufacturing plant materials. **R. G. LeTourneau, Inc., CE 1-116, Longview, Texas.**

CONCRETE AND MASONRY CONSTRUCTION—A comprehensive 16-page catalog is now available, showing a complete line of concrete, masonry, lathing and carpentry accessories. In addition to well-known items such as form ties, spreaders, high chairs, several unique construction aids are described and illustrated. Among these is the "Simp-L-On" furring system, attachable with equal ease to brick, block or concrete by a combination of shields, brackets and V-strips. Also included are descriptions and drawings of a new assortment of hangers for suspended ceilings as well as solid plaster partitions, speedily erected with channels, runners and curved or square end forms. **Conver Steel & Wire Co., Inc., CE 1-116, 600 East 132nd St., New York 54, N.Y.**

DEEP HOLE DRILLING—Authoritative application data on deep hole drilling with precussion rock drills has been published in booklet form for the convenience of mine and quarry operators and contractors engaged in rock excavation. Thirteen pages of original application drawings suggest some of the varied uses for this efficient drilling method, including vertical and horizontal ring drilling, pillar recover, block caving, exploration and sampling, conduit drilling, demolition work, and deep hole percussion drilling in quarries, open pit mines and surface rock cuts. The booklet also describes a complete line of equipment for deep hole percussion drilling. **Gardner-Denver Company, CE 1-116, Quincy, Ill.**

WATERSTOPS—Two new waterstops, the Labyrinth and the Flextrip, are described in a recent catalog. The catalog depicts the Labyrinth waterstops as very economical to install because no splitting of the form is required. The polyvinyl plastic out of which the Labyrinth and Flextrip waterstops are extruded is extremely resistant to deterioration caused by aging, acids, alkalis, petroleum products and the organic products associated with sewage treatment plants. **Water Seals, Inc., CE 1-116, 9 S. Clinton St., Chicago 6, Ill.**

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Sewage Regulators

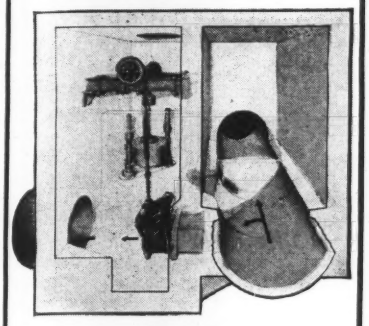

Fig. B-19

Automatic Sewage Regulators control sewage flows either by partially or completely cutting off such flows to suit head or tail water conditions or by "governing" to discharge a predetermined quantity regardless of head or tail water conditions.

Descriptive Bulletins and Engineering Data Available Upon Request

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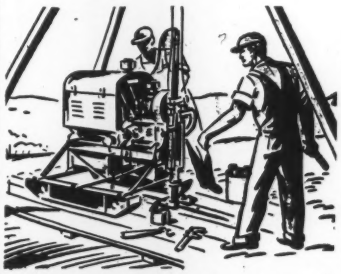

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From the MANUFACTURERS

Wonder Building Begins Exporting

To market their all steel, trussless, clear span building throughout the world the Wonder Building Corporation of America is launching an exporting program. This marks the first time that this steel pre-fab building manufacturer has entered the exporting field.

Engel E. Devendorf of New York has been appointed Executive Representative of the corporation, in charge of the export operations and of all the firm's activities in the eastern section of the United States, by Peter S. Pedersen, president of the company.

Devendorf was formerly associated with C. S. Greene & Co., Inc., of New York as a consultant on development of sales, managing all sales to foreign markets, and prior to that, was with Pfizer International Services, Inc., of New York, as territorial manager of sales operations. He will carry on this exporting operation out of the Chrysler Building offices.

Gardner Denver Appoints New Export Officers

The Gardner-Denver Company recently appointed A. H. Jones, the former vice president in charge of the export division, to the post of vice president and director of export sales for the company. Mr. Jones will remain at Gardner-Denver's New York export offices.

G. V. Leece, company president who announced Jones's appointment, also named Norman Nevin manager of the export offices, with headquarters in New York. Mr. Nevin has been district manager of the Gardner-Denver branch office in Lima, Peru.

At the same time, Mr. Leece announced that John J. Mastrovich was named district manager of the Lima office. Mr. Mastrovich joined the organization in 1941. Since 1946, when he returned from the service, he has served Gardner-Denver in Peru and Chile. He will continue his work in these countries now as district sales manager.

Le Roi Creates New Post

Le Roi Division of Westinghouse Air Brake Company in Milwaukee has named Don S. Permar to the newly created post of field sales manager. Permar will have overall responsibility in managing the Le Roi field sales organization. He will provide administrative liaison between the factory and field sales staffs in the district sales offices.

The Le Roi Division is responsible for the marketing of Westinghouse industrial compressors, Le Roi portable compressors and the Tractair, in addition to front end loaders, concrete mixers, and heavy duty gasoline engines.

SURVEYING NEWS

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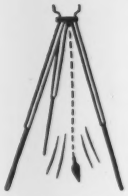

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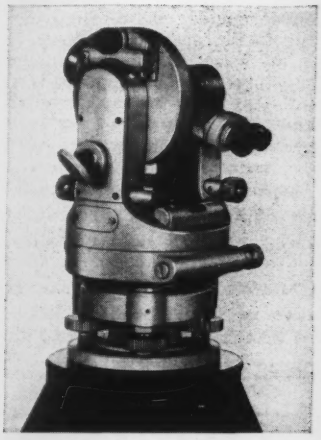

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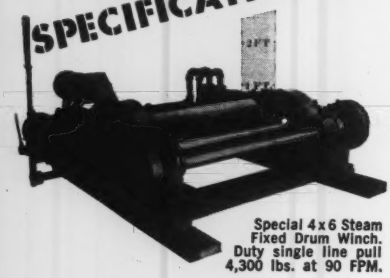

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From the MANUFACTURERS

Worthington Sponsers Machinery Exhibit

The first observer-participant educational exhibit to be sponsored by an industrial machinery manufacturer has been opened by Worthington Corporation. The permanent exhibit, located at 99 Park Avenue, New York, illustrates basic operating principles of machinery related to business, industrial, community and home life.

Among the displays is one showing how air conditioning works; and a three-dimensional composite of community life where factories, marine operations, railroads, road-building crews, office buildings, homes, power generating plants, water and sewage works are all represented.

By operating the displays himself, the visitor gains a working insight of the various machines.

Huber, Riddell Plan To Consolidate

What were formerly The Huber Manufacturing Company of Marion, Ohio and The W. A. Riddell Corporation of Bucyrus, Ohio have decided to become The Huber-Warco Company. They plan to consolidate general offices in Marion and to continue manufacturing operations at plants in Marion and Bucyrus.

Clark T. McConnell, former president of Warco, was elected chairman of the board for Huber-Warco. He is a partner in a Cleveland law firm and an officer and director of The Ideal Electric Company of Mansfield and the Dobeckmun Company of Cleveland.

Don A. Howard, former Huber president, is president of Huber-Warco. Jacque E. Jones of Bucyrus, who has been vice president and general manager of The W. A. Riddell Company for several years, was named executive vice president of Huber-Warco. Ralph Howard of Marion was elected vice president. Robert E. O'Connell of Marion, treasurer of the Huber Company, was elected treasurer of Huber-Warco. Baird Johnson was elected secretary.

Huber for many years has manufactured a complete line of three-wheel rollers, tandem rollers and a road maintainer. The W. A. Riddell Corporation has manufactured a complete line of motor graders and grinding machinery used in the preparation of aggregates.

Acker Drill Completes Addition

In an expansion of its present facilities in Scranton, Pa., the Acker Drill Company, Inc., manufacturers of drilling equipment and accessories, recently completed an addition to their plant. The new wing, of brick and steel construction, provides a manufacturing area of over 35,000 sq ft. It has been equipped with the latest machine tools.

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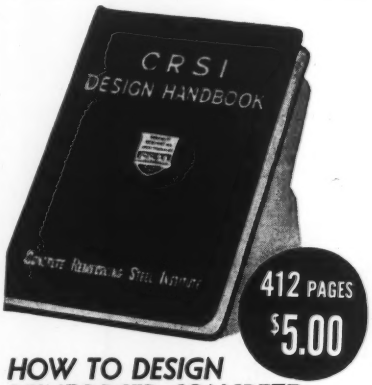

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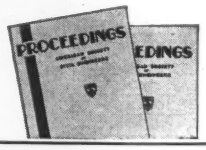

PROCEEDINGS AVAILABLE

The following papers have become available as Proceedings-Separates. Following the date of issue of a paper, discussions thereof will be received for a period of three months, as specified on the cover of the paper. Titles will be added to this list every month, as they become available. Technical Division sponsorship is indicated by an abbreviation at the end of each item, the symbols referring to: Air Transport (AT), City Planning (CP), Construction (CO), Engineering Mechanics (EM), Highway (HW), Hydraulics (HY), Irrigation and Drainage (IR), Power (PO), Sanitary Engineering (SA), Soil Mechanics and Foundations (SM), Structural (ST), Surveying and Mapping (SU), and Waterways (WW) divisions. Papers issued prior to, and including, Separate No. 289, were not distributed under the present automatic mailing system. If you have not registered in a Technical Division to receive its papers (one Division only) free of charge, please do so promptly by filling out and mailing the enrollment and subscription form (page 121) to Society Headquarters. For ordering separate papers, use the convenient order form on page 120.

Listed in Earlier Issues

553. Discussion of Proceedings-Separates 315, 325, 328, 385, 416, 417, 435. (SM)

554. Cooperation Between Industries and Regulatory Agencies, by John E. Kinney. (SA)

555. Water Supply Problems, by Francis S. Friel. (SA)

556. Composting and Grinding: Report of a Subcommittee of the Committee of Refuse Collection and Disposal of the Sanitary Engineering Division. (SA)

557. State Activities and Fiscal Aspects: Report of a Subcommittee of the Committee on Refuse Collection and Disposal of the Sanitary Engineering Division. (SA)

December

558. An Influence Line Analysis for Suspension Bridges, by David J. Peery. (ST) Long-span suspension bridges cannot be analyzed by usual procedures for elastic structures. The differential equations for a suspension bridge truss are shown to be identical to the equations for a beam in tension. A hypothetical tension force is therefore assumed to act on the stiffening truss at all times. Influence lines are calculated as deflection curves of beams in tension. The ordinates of deflection curves can be readily tabulated in dimensionless form. Final bending moments are obtained by linear interpolation.

559. Mackinac Straits Bridge, by D. B. Steinman. (ST) The need for bridging Mackinac Straits in Michigan is described in terms of the industrial potential of the Great Lakes area, the growth of traffic, and the estimated annual revenue to be derived from tolls. Of primary interest is the description of the proportions of the 3,800-ft span suspension bridge. The governing features of the design of the foundations are outlined, the cost of the project is summarized, and its economic justification and financial feasibility are discussed.

560. Analysis of the Vierendeel Girder by Balancing the Panel Moments, by A. F. Diwan. (ST) A special type of panel displacement is developed which produces moments in the chords of the distorted panel only and nowhere else in the Vierendeel. This makes possible an analysis by successive operations of joint rotations and special panel displacements, by which the moments in the joints and in the panels are successively balanced.

561. Foundation Failures in Residences and Small Structures, by Karl V. Taylor. (ST) The paper is concerned principally with building settlements that are associated with prolonged drought conditions. The mechanics of the shrinkage and swell of soils are reviewed briefly. Behavior characteristics of certain types of soil masses subjected to severe desiccation are related to settlement processes.

562. Moments and Deflections in Steel Grid Bridge Floors, by H. J. Greenberg. (ST) Formulas, which can be used in the specifications and design of steel-grid highway bridge floors, are proposed to calculate the maximum deflection and maximum negative edge-moment occurring in a steel-grid highway bridge floor under wheel loads. Separate formulas are given for concrete-filled steel grid floors and open-grid steel floors.

563. Discussion of Proceedings-Separates 219, 298, 322, 430, 441, 449, 468. (ST)

564. Hydraulics of the Free Overfall, by A. Fathy and Mahmoud Shaarawi Amin. (HY) The Free Overfall has been dealt with only in global terms and has been based on certain arbitrary assumptions as regards internal pressure distribution. An account is given of a theoretical and experimental investigation of the problem on the basis of actual velocity and pressure distributions in the nappe. Variability of the bedslope in the approach channel is taken into consideration.

565. The Present Status of Research on Sediment Transport, by Ning Chien. (HY) The problem of sediment transport, as it is known today, is discussed briefly in the paper: The significance and implications of the various phases of the problem are emphasized; controversial issues are discussed; and efforts are made to unify some of the highly diversified results.

566. Similarity of Distorted River Models with Movable Bed, by H. A. Einstein and Ning Chien. (HY) The similarity conditions for distorted river models with movable bed are derived from the theoretical and empirical equations which have been found to describe the hydraulics and the sediment transport in such rivers. A complete numerical example is added to demonstrate the method of application to a particular river.

567. Flow Expansion and Pressure Recovery in Fluids, by Harold Tults. (HY) Investigating the possibility of improving the pressure recovery in flow expansions, the

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writer observed visually the separation phenomena and measured the development of velocity profiles and pressure distribution in a gradual, unilaterally expanding, two-dimensional, rectangular test canal with varied divergence of from zero degrees to twenty degrees in range of Reynolds number 5×10^4 to 3×10^5. Two characteristic phases of separation phenomena—"instant-stop" and "separation start"—and their locations in expansion were measured and photographed by flashlights.

568. Discussion of Proceedings-Separates 432, 438, 439, 489. (HY)

569. A Soil Pressure Gauge for Laboratory Model Research, by Peter W. Rowe. (SM) A soil pressure gauge of 1.50-in. diameter, suitable for pressure ranges of from 0.01 to 0.50 lb per sq in., is described in the paper. The gauge is free of error due to soil arching and zero wander and is particularly suitable for investigating the distribution of soil pressures on laboratory models of structures.

570. Effect of Sample Disturbance on the Strength of a Clay, by Max L. Calhoon. (SM) Of the many variables that influence the laboratory test shearing strength of saturated homogeneous clays, the effect of sample disturbance (partial remolding) has received little constructive analysis. It is demonstrated for certain clay soils of the type tested that, because of sample disturbance, the actual field shear strength may be less than the laboratory test shear strength.

571. Effectiveness of Sand Drains on New Jersey Turnpike, by Charles M. Noble and O. J. Porter. (SM) The paper describes the extensive use of sand drains on the New Jersey Turnpike in 1950 and 1951. Foundations were stabilized for many heavy embankments ranging up to more than 50 ft in height over marsh muds extending to 100 ft in depth. Data are included to show that the treatment proved to be successful in spite of a fast construction schedule.

572. Discussion of Proceedings-Separates 262, 445. (SM)

573. Discussion of Proceedings-Separates 386, 456. (SM)

574. Photogrammetry in City Planning and Operations, by Louis A. Woodward. (SU) The poorly planned city, frequently encountered today, is largely the result of inadequate maps. It is suggested that city engineers make a studied effort to secure, by the use of photogrammetry, adequate maps for their communities so that improvements can be planned in an efficient manner. It is contended that photogrammetry offers the fastest and most economical method of securing these maps; examples are presented in which the cost of the photogrammetric survey was recovered on the first major project that was undertaken following the survey.

575. A Geometric Problem in Traveling Crane Track Alignment, by J. E. Oliver and F. A. Maloney. (SU) The problem consists of determining the gage reductions necessary to permit a traveling crane to negotiate sharp-radius curves and the changes in radii and gages in effecting a transition from the tangent gage to the reduced gage. The cubic spiral has been used in this solution because it is a most adaptable transition curve, and spiral tables are readily available to reduce computations.

576. Plane Coordinates for Industrial Sites, by Max O. Laird. (SU) Industrial developments are characterized by relatively large tracts of from 25 to 2,500 acres, large total investments, and great concentrations of plant. Economic considerations make it infeasible to move to a new site; therefore, an initial period of growth is followed by a period of additions, removals, and rearrangements. General economic and technical requirements for controlled surveying and mapping at industrial sites are discussed. Important are the net savings which result from using State Plane Coordinate control. An application of State Plane Coordinate Control to a radio station is described.

577. Photogrammetry Aids the Pennsylvania Turnpike, by G. B. Gilbert. (SU) There are presented the photogrammetric methods applied to planning the construction of the Pennsylvania Turnpike with resultant cost and time savings, and the production of accurate topographic maps with a minimum of field survey work. The advantages gained through the use of photogrammetry are noted, especially those dealing with alinement, drainage, and earthwork.

578. Interaction Between Well and Aquifer, by Wen-Hsiung Li. (HY) An investigation is made to find the effect of the variation of piezometric head along the well on the flow in the aquifer. It is found that, with laminar flow through the aquifer, the formation loss involves a term roughly equal to the velocity head of well discharge. The loss through the well screen is usually negligible. What is usually considered to be the screen loss is actually an additional loss caused by the variation of piezometric head along the well. A solution is obtained for the flow into a fully penetrating well from a confined uniform aquifer.

579. Unsymmetrical Concrete Beam Loaded in Two Directions, by W. D. Bigler. (ST) Reinforced-concrete beams subjected to two-way bending forces are difficult to design because the location and direction of the neutral axis cannot be found by direct computation. The paper describes a method of designing irregularly-shaped as well as rectangular beams loaded in two directions and includes suggestions for eliminating torsion.

580. An Industry Puts the Texas Coordinate System to Work, by H. P. Cooper. (SU) Industrial application, development, and use of a state coordinate system for locating land boundaries, and the advantages and disadvantages of the system, are discussed. The paper describes why additional control stations were necessary, how nineteen second-order control stations were established, and how these stations are being used.

581. Photogrammetry and its Application, by A. O. Quinn. (SU) Photogrammetry's roots in spatial geometry and some of the precise instruments used in air mapping are described. Practical applications of the science of photogrammetry in city mapping, detail site maps for large industrial facilities, highway maps, and profiles for power and pipe lines are outlined.

582. Index to Proceedings, Volumes 76 to 80 (1950–1954), by the Board of Direction, Committee on Publications. A subject and author index has been prepared for all Proceedings-Separates since No. 1. The indexes for the five annual volumes are compiled separately so that one can detach them and assemble each index with the appropriate volume. The subject headings that were used were taken from the names of the technical divisions; other headings were added when deemed necessary. By use of this index it is possible to trace the discussion that a paper has received, a feature that has long been sought by technical readers.

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